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to the odd isotopes (8.68%). Some other lines of zinc have also been analysed.

24. Hyperfine Structure of certain *HgI* Lines in the Electrodeless Discharge.

T. S. SUBBARAYA *and* T. G. SRINIVASA IYENGAR.

The fine structure of a number of *HgI* lines has been investigated using as source mercury vapour rendered luminous by an electrodeless discharge. Over the tube a coil of thin copper wire was wound closely, this forming the inductance in the oscillatory circuit consisting of the coil, six Leyden-jars of medium size and an adjustable spark gap all in series. The circuit was fed by a 10,000 volt wireless transformer taking 110 volts, 25 cycles *A.C.* supply.

The work was undertaken to test the correctness of the result of Tolansky who using the electrodeless discharge as the mode of excitation reported that the line 4916 (6^1P_1–8^1S_0) did not show the structure recorded by Venkatesachar and Sibaiya (*J. Mys. Univ.*, Vol. 4, p. 145, 1930). The following lines have also been analysed; 6234, 6123, 6076 and 5461.

The structure of 4916 as recorded by Venkatesachar and Sibaiya is essentially correct.

The relative intensities of Satellites in the case of 5461 is different in the electrodeless discharge from that in an arc discharge. Large and apparently irregular changes in the relative intensities of the Satellites are noted, small changes in the conditions, e.g., of pressure and temperature producing marked effect.

25. Revision of the Hyperfine Structure Data of some Prominent Mercury Lines.

L. SIBAIYA.

Though the *HgI* lines have been analysed by a number of investigators a re-examination of the lines has revealed the indubitable existence of satellites that have not been recorded hitherto. This work was undertaken in view of the importance of hyperfine structure data for testing recent theories regarding the origin of satellites. It is realised that one has to be very cautious before being certain of the existence of new satellites, often faint, in the case of lines that have been carefully examined by others. It is concluded however that even the line 5461 Å has undoubtedly one more satellite at -0.154 Å. Again the line 5769 Å has shown a structure containing three additional satellites at -0.173, -0.213 and -0.257 Å. The structure of the line 4916 Å has been re-examined in view of Tolansky's negative result (Tolansky, *Proc. Roy. Soc.*, Vol. 130, p. 558, 1931) and the new analysis is in agreement with the previous one (Venkatesachar and Sibaiya, *Mys. Univ. Jour.*, IV, pp. 145-8, 1930). The following lines have also been analysed :—

HgI : 4108, 5026, 6234, 6907, 7092 Å.
HgII : (after Paschen) : 3984 Å.
Unclassified line of mercury : 6123 Å.

The structure of the *HgI* lines was shown to be adequately accounted for by ascribing a spin of ½ and 1½ to the nucleus of the odd isotopes (Venkatesachar and Sibaiya, *Mys. Univ. Jour.*, IV, pp. 145-8, 1920). The recent analysis is in agreement with this hypothesis if it is further assumed that the stronger satellites are caused by isotopes with nuclear spin of ½ and the comparatively weaker ones by isotopes with a spin of 1½. Schüler and Keystone have recently come to a similar conclusion. (Schüler and Keystone, *Naturwiss.* 31, p. 676, July 1931.)

26. An Extension of the Analysis of the First Spark Spectrum of Mercury (*HgII*).

B. VENKATESACHAR *and* T. S. SUBBARAYA.

The *HgII* spectrum has been analysed by Paschen (F. Paschen, *Ber. d. Preuss. Akad. d. Wiss.* Berlin, 32, p. 536, 1928) and further by Naude (S. M. Naude, *Ann. d. Physik*, 3, p 1, 1929). Though a large number of lines have come within the scope of the analysis of these authors, there are other characteristic lines which have not been classified. Starting from the behaviour (B. Venkatesachar, *Proc. Roy. Soc. A.*, 117, p. 26, 1927) of the spark lines in respect of relative intensity when the density of the vapour in a mercury arc is changed from about 2 mm. to about 0.1 mm., we have found a number of new terms resulting from the configurations $5d^9 6s 7s$, $5d^9 6s 6d$, and $5d^9 6p^2$. Displaced (verschoben) series of the type found by Paschen in Neon have been found to occur in *HgII* also, together with the corresponding ordinary series. The new terms account for 74 lines now classified.

27. Light Emission from Hydrogen under Impact from Positive-Ray Particles of Hydrogen.

B. DASANNACHARYA, Benares.

The amount of light J_p given out depends on the energy E_p of the Positive-Ray and also on the pressure p of hydrogen. Per unit of pressure and unit of energy, the value of J_p is equal to $A.V.\exp.-B.V.\log.\ p$. Here A and B are constants and independent of the voltage in the discharge tube as well as on the pressure p of hydrogen in the collision chamber. The unit of p is 0.001 mm. The above results are deduced from measurements with H_β and $H\gamma$ of hydrogen, (in the undisplaced line).

28. On a Cubic Transformation in Circle-Geometry.

B. RAMAMURTHY, Annamalai Nagar.

Let A_0, A_1, A_2, A_3 be four fixed points in general position in the Gauss plane. Taking any arbitrary point P, let circles PA_0A_1, PA_2A_3 intersect again at P_1. Similarly let circles PA_0A_2, PA_1A_3 intersect again at P_2 and circles PA_0A_3, PA_1A_2 at P_3. The object of this paper is to examine the transformation T_1 which carries P to P_1 and obtain the group generated by the transformations T_1, T_2, T_3 which carry P to P_1, P_2, P_3 respectively. It is found to be an Abelian group of order 8 whose elements are E, I_1, I_2, I_3; T_1, T_2, T_3, where E is identity, I_1, I_2, I_3 the three mutually harmonic involutions in the Gauss plane defined by the tetrad $A_0A_1A_2A_3$ and Γ the generalised isogonal transformation with respect to $A_0A_1A_2A_3$ studied in detail by Dr. R. Vaidyanathaswamy in his memoir on the cubic transformation associated with a desmic system.

The results that $I_1 = T_2T_3$ and $\Gamma = T_1T_2T_3$ give simple inversionally invariant constructions for the mate of any point in I_1 and Γ

In the last section, I obtain the curve of double points for T (T_1, T_2 or T_3) and the cyclics admitting the above group.

The problem is studied by means of the familiar representation of the manifold of circles in the plane by the points of a space S_3 of three dimensions, the submanifold of point-circles corresponding to the points on a Quadric Q; so that any circular transformation in the Gauss plane corresponds to a collineation in S_3 which leaves Q invariant.

29. On some lines in the Arc Spectrum of Lead.

S. B. L. Mathur, Bombay.

Since the time Michelson with the aid of his interferometer studied the structure of spectral lines considerable advance has been made not only in the technique, but also in the theory of the causes to which the complexity is ascribed. Much of the earlier data on fine structures is untrustworthy for experimental reasons. They have been studied by Joos, and, by Ruark and Chenault, who showed that fine structures of the spectral terms are responsible for the fine structures of the lines. A fine quantum number, f, was introduced to distinguish the various levels of a complex spectral term, and showed that in some cases this quantum number obeys the selection rule $\Delta f = \pm 1$ or 0. It is not, however, the only solution offered. Nagaoka, Suguira and Mishima suggested that the various components of a spectral line are emitted by different isotopes. This is, however, not quite correct. Pauli suggested that the origin of the fine structures may be explained by assuming that the nucleus possesses angular momentum and magnetic movement. Goudsmit and Back and others have supported this view.

In the work under report, the structure of some lines of lead was studied with the aid of a Fuess quartz spectrograph, and, a Lummer Gehrcke plate. The source of light was a lead arc struck by means of an electromagnetic device in vacuum. This arrangement was, however, not entirely satisfactory. Several cases of self-reversals were noted. Other methods have been tried.

30. A study of some Arc Lines of Copper.

S. B. L. Mathur, Bombay.

With the same experimental arrangements as outlined above a number of copper lines were investigated.

31. An Inertia Wheel control for large Clock Movements.

H. Parameswaran.

In designs of large tower clocks employing gravity lever escapement means have to be provided for restraining the motion of the escape wheel when released. It is usual to employ a large vane nearly two feet in diameter. This makes the design cumbersome and large. An alternative idea recently tried out by the author in the construction of a large tower clock with six feet dials is discussed in the paper. This consists of a small inertia wheel about four inches in diameter slippingly attached on the escapement shaft with adjustable friction.

32. The Sea breeze at Karachi.

L. A. Ramdas, Poona.

Local land and sea breezes occur at Karachi during the period October to March. The sea breeze which sets in during the afternoon has some of the characteristics of a cold front; it sets in suddenly, is usually colder, more moist and has a larger velocity than the preceding land breeze. Part I of the present paper gives some statistical data about sea breeze. In Part II a few typical instances of sea breeze during the winter of 1930-31 when special surface and pilot balloon observations were recorded are discussed. In Part III the thickness of sea breeze on a few occasions computed from surface pressure and temperature recorded at Manora and the Airship Base Observatories according to Humphreys' theory has been shown to agree fairly well with observed values. Jeffreys' theory of antitriptic winds accounts only for the broad features of sea breeze; the cal-

culated values of thickness and velocity of sea breeze are found to be much smaller than the observed.

33. A simple Method of Calculating the Roughness of Pure Liquid Surfaces due to Molecular Agitation.

L. A. RAMDAS, Poona.

The thickness of the transition layer at the surfaces of liquids may be calculated directly to the first order of approximation in the following manner :—

The liquid surface is disturbed by molecular bombardments which cause it to be deformed by the innumerable wavelets whose amplitudes are of molecular dimensions.

We may consider that a plane surface element, circular in shape, gets deformed into a spherical cap. The increase in area of the deformed surface element multiplied by the surface tension gives the work done and this may be put equal to the potential energy $\frac{1}{2}RT$. The maximum vertical displacement h of the deformed surface element comes out as

$\sqrt{\frac{1}{2}\frac{RT}{\pi\gamma}}$, where R is Boltzmann's constant, T is absolute temperature, and γ is the surface tension.

The values of h calculated from the above expression are of the order of molecular dimensions.

34. Spectrum of Glow-worm.

L. A. RAMDAS *and* S. P. VENKATESWARAN, Poona.

It is well known that the luminous organs of insects like the fire-fly represent one of the most efficient sources of light in that almost all the energy is concentrated in a narrow band in the spectrum.

We had recently an opportunity to photograph the spectrum of a glow-worm which belongs probably to one of the species of 'Lampyridae'. The spectrum of the light emitted was photographed on an Ilford Panchromatic plate with a night-sky spectrograph. The spectrum consisted of a single band extending from 5290 to 5860 A.U., i.e., only half as broad as the band in the spectrum of the fire-fly.

The glow-worm was not seen to emit any light by day even when observed in a dark room. Even at night the emission is not continuous. The worm can apparently do this at will. Slight irritation or shaking seems to make it well disposed to glow very brilliantly.

35. On Extreme Dryness observed at Kodaikanal in Winter.

S. L. MALURKAR, Poona.

At Kodaikanal and other hill stations of South India which are at an elevation of about 2 kms. above sea-level extremely dry days when the relative humidity may fall to one or two per cent., are experienced during the winter months. From all the available data a study of the phenomenon has been made and the conclusion 'that air is subsiding at upper air levels on most days and that sometimes the subsidence occurs up to the levels of the hill stations when extreme dryness is experienced', is drawn.

36. Extremely large Lapse-rates in the immediate neighbourhood of the heated ground and inferior Mirages.

S. L. MALURKAR *and* L. A. RAMDAS, Poona.

It is well known that on clear days mirage can be seen over the modern paved roads. But the variation of the temperature in the neighbourhood

is not yet well known. An attempt to measure the temperatures at Poona very near the ground was made last summer. It was found that extremely large lapse-rates as high as ten thousand times the adiabatic lapse-rate are not uncommon within a few centimetres of the ground. A mathematical theory of such rapid fall of temperature with height near the ground has been worked out. The observations are accounted for by the proposed theory.

37. On properties of a Linear Complex referred to which a given Hexagon is Self-conjugate.

P. N. DAS GUPTA, Patna.

Turnbull has shewn that there is a unique linear complex referred to which a six-sided figure in three dimensional space is such that the sides are lines of the complex. Some properties of this linear complex is studied in this paper with generalisation in n-space.

38. Observations on the nature of Lamp and Lunar Coronae.

A. R. KHAN, Osmania University.

This paper deals with observations made on the nature and formation of lamp and lunar coronae (formed especially in the absence of mist or visible drops of water between the source of light and the observer), with a view to investigate the meteorological conditions under which they are formed.

39. Measurement of refractive Index of Water for different Wave-lengths.

MD. ZULFIQAR HUSSAIN FARUQUI, Osmania University.

This paper gives a detailed account of experiments conducted at the Osmania University College under the supervision of Prof. Mohd. Abdur Rahman Khan to find the refractive index of distilled air-free water for different wave-lengths running from 4383×10^{-8}cm. to 6687×10^{-8}cm.; values for ordinary distilled water (not free from dissolved air) are also obtained. The apparatus employed was Rayleigh's Refractometer manufactured by Adam Hilger Ltd., London. The source of light used was the iron arc and the lines were dispersed by a constant deviation Spectrometer. All the readings were taken at 30 C.

40. The Vertical Optical Bench.

ABDUR R. KHAN, Osmania University.

A simple apparatus called the Vertical Optical Bench, of small size and compact form giving very accurate results has been designed by the writer of the present paper and manufactured by Messrs. Flatters and Garnett of Manchester. It has been described in the *Journal of Scientific Instruments*, London, Vol. VI, No. 10, October 1929, omitting details of manipulation and calculation of results. These are given in the present paper at some length to show the use of the apparatus in optical experiments.

41. Audio-frequency Constants of Circuits and Telephone Lines.

S. P. CHAKRAVARTI.

Existing standard methods of measurement of circuit constants by frequency bridges are laborious, require expensive apparatus and become difficult at radio, carrier and higher audible frequencies. Prof. Mallett

developed simpler methods to determine f_r and Δ of electro-mechanical vibrators and deduced the dynamical constants of the vibrators. The author, in another paper, extended his methods to still complicated types of vibrators. Further, Prof. Mallett and Blumlein applied the methods to find the H. F. resistance of coils, circuits, etc. The author's present paper extends the application to the carrier and higher audible frequency region.

The measurements were confined to the frequency band 3 Kc. to 9 Kc/Sec: f_r and Δ of ordinary and telephone circuits were determined from the $\frac{Z}{Zd} - f$ curves and derived vector diagrams, (which are circular). R and L of the circuits at about 6530 CYCLES/SEC. were deduced. Further, a circuit capacity variation (of the order of ·0005 μF's) could be easily determined by the application of the methods. The capacity of the telephone and other circuits at about 6530 Cycles/Sec. were found out.

42. Performance of Copper oxide rectifier at high frequencies.

AIJAZ MOHAMMED *and* T. S. RANGACHARI.

Since the advent of broadcast reception as a popular recreation the demand for an efficient type of radio frequency detector has been very keen. The crystal, the thermionic valve grid and anode bend detectors need external polarising batteries for efficient operation. The Copper oxide—Copper type of dry contact detector needs no such batteries, can be handled roughly without effecting the contact properties. The paper shows by means of comparative performance curves that for voltages up to 1·8 effective value, cu-oxide rectifier is more efficient than the anode bend and crystal detectors, and is only a shade less so than Cumulative grid. Beyond two volts however it is decidedly more efficient than the other types Rectification diminishes with increase in frequency but the superiority of copper oxide is still maintained It is suggested that for good headphone reception of local broadcast transmissions it is the most convenient rectifier.

43. Power Losses in Pyrex Insulators.

N. V. NARAYANASWAMI, Bangalore.

A study of the power losses occurring in insulators made of Pyrex glass designed for different working voltages was made with a view to compare them with those in similar porcelain insulators. The Pyrex insulators were supplied by the Corning Glass Works for use on 8, 23 and 40 k.v. lines respectively and were stressed to different voltages up to the working pressure. The measurements were taken under ordinary laboratory conditions of temperature and pressure on a Schering Bridge. The observations show that with increasing stress, the power factor gradually increases from about 0·1 to 0·3 and the capacity also increases, indicating an increase in the dielectric constant of pyrex glass. The losses at the working voltage are of the order of 2 to 3 watts. In the case of porcelain insulators for 5 and 40 k.v. lines, the increase of power factor with increasing stress is only from 0·25 to 0·3 and the capacity also shows only a small increase, indicating small variation in the dielectric constant of porcelain. The dielectric losses are of the same order as in the Pyrex insulators. These observations do not indicate any superiority of the one or the other type of insulator but the smaller size of Pyrex insulators appears to be a point in their favour.

44. A new type of Permeameter.

K. V. KARANTHA.

A new type of permeameter suitable for commercial testing of magnetic materials and capable of a high degree of accuracy for this class of

work is described. In this permeameter the specimens are cut in the shape of circular plates about 4" in diameter, with a central hole of 7/8" diameter through which the magnetising ampere-turns are threaded in the shape of a rectangular coil 3 ft. × 9½ ft. The flux paths through the specimen are circular and the values of magnetic induction is determined by means of a search coil of a few turns threaded through two small holes drilled in the sample. The corresponding values of *H* can be easily calculated from the value of the magnetising current and the constants of the instrument. Results of the tests on wrought iron are given and these agree closely with those obtained by the anchor ring method. The permeameter possesses the advantage that the samples are easy to prepare and the operation of testing is very simple.

45. Measurement of small capacities at Radio Frequencies.

V. V. SATHE *and* T. S. RANGACHARI.

Bridge methods of measuring small capacities of the order of a few $\mu\mu F$ usually give unreliable results particularly at radio frequencies. Direct substitution methods are to be preferred. This paper deals with a modification of the substitution method utilising a low decrement resonant circuit. The unknown condenser is made to alter the frequency of a valve oscillator, these alterations are subsequently neutralised by variation of a standard condenser incorporated in the circuit. The low decrement circuit with a rectifier forms the indicator. A small fixed condenser with a cut-out switch enables detection being always carried out at the same points of the resonance curve. Figures are given for the residual capacities of small condensers, short lengths of lighting flexible, interelectrode capacities of valves, all as obtained by this method.

46. On Rectification by an Imperfect Metal to Metal Contact.

S. P. CHAKRAVARTI.

The paper gives an account of the rectifying action of an imperfect contact formed by Brass and Iron for alternating currents of frequencies of 569 and 1195 Cycles/Sec., and of the effect of the magnetic fields of different strengths on the phenomenon.

The static and dynamic characteristics show a possibility of rectification when brass has positive bias with respect to iron. The rectification is altered by a magnetic field acting along the metals. The contact placed in a weak magnetic field has better rectifier property than in a strong field.

47. Investigations on design of a Band Pass Filter.

S. P. CHAKRAVARTI.

A band pass filter (for the band 12 to 15 KC/Sec.) is designed and constructed for carrier current telephony. Measurements are taken for output current—frequency characteristics with coils in the two stages uncoupled and then coupled. The former measurements give slightly peaky characteristic within the band, while the latter gives flat characteristic. The slight shift of the band (upwards in the scale) is mainly due to inaccuracies in frequency calibration.

Two types of characteristics are derived. The theoretical characteristic is obtained by keeping the input voltage exactly the same all the time, and the working characteristic by keeping the impedance at the mean value. The working carrier frequency should be chosen from a consideration of the latter characteristic.

The sharpness of cut off can be improved by reducing the input impedance to about 70 per cent. of the filter surge impedance. The $\frac{I_H}{I_C}$ —

input impedance curve is hyperbolic. The variation of the output impedance to the same extent does not affect the sharpness of the lower or higher cut off, and the curves are flat.

48. Specific Heat in Relation to Raman Effect Data.

S. PARAMASIVAN, Madras.

Specific heat is correlated with the Raman effect data on the assumption that the Raman lines are caused by transitions corresponding to the fundamental frequencies involved in the scattering process. Following Einstein's theory of specific heat, the specific heat values of molecules of widely differing atomic configuration are calculated and these values agree with those actually observed, thereby affording a quantitative proof for the fact that the Raman frequency shifts are the fundamentals.

49. A Study of the Structure of the Pedal and Contact Circle systems of a triangle.

A. NARASINGA RAO, Annamalai Nagar.

The pedal circle of a point P *w.r.t.* a triangle ABC is the circle through the feet of perpendiculars from P on its sides, while the contact circle has been defined by Mr. Bhimasena Rao as the circle through the points of contact of an inconic of ABC with centre at P. The totality of pedal and contact circle systems of a triangle are here studied and their structure discussed by representing circles *in plano* by points in 3-space with an Absolute Quadric and the 3-dimensional significance of known results regarding these circles are examined.

50. On the Critical Absorption Method of Measuring the Compton Effect.

A. S. GANESAN, Nagpur.

For a quantitative determination of the Compton effect by the method of Raman and Sogani we should have a precise relation connecting the absorption coefficient and the wave-length. The absorption formulæ of Owen, Richtmyer and Hewlett apply only over a limited range and are unsatisfactory for short wave-lengths. Compton's expression $\mu_a = KZ^4\lambda^3 + Z\delta o/(1+2a)$, where $a = h/mc\lambda$, overcomes this difficulty but breaks down at the critical absorption limit. Based on this expression empirical formulæ are derived which are of the form $\mu = \mu_a\ (A - B\lambda + C/\lambda)$ where μ_a is the coefficient calculated according to Compton's relation and A, B, C, are constants. This form holds good especially for high atomic weight elements and gives values on both sides of the critical absorption wave-length. An expression is derived for the Compton shift in terms of quantities that can be determined experimentally by this method.

51. Susceptibility of Liquids by pendant drops.

L. SIBAIYA *and* H. S. VENKATARAMIAH.

The values for magnetic susceptibilities of liquids and liquid mixtures given by different observers differ by amounts which are often marked. For instance in the case of acetone the specific susceptibility value of Pascal is $-0{\cdot}581 \times 10^{-6}$, whereas that of Trew and Spencer (*Proc. Roy. Soc.*, Vol. 131, p. 211, 1931) is $-1{\cdot}229 \times 10^{-6}$, nearly double the previous value. Some of the results of Trew and Spencer have been recently questioned by Ranganadham (*Nature*, Vol. 127, p. 975, 1931). With the object of obtaining consistent values for the susceptibilities and accounting if possible for their variations, we have recently adopted an improved

form of apparatus for measuring them by weighing a liquid drop in a non-homogeneous magnetic field first employed by Abonnenc (*Comp. Ren.*, Vol. 190, pp. 1395–7, 1930). Assuming the specific susceptibility of water as $-0{\cdot}72\times10^{-6}$, the value for Acetone has been found to be $-0{\cdot}567\times10^{-6}$ and this result agrees closely with the calculated and observed values of Pascal. Further experiments are being conducted on organic liquids and their mixtures.

52. Measurements of sound transmission coefficients of certain materials.

C. V. PATEL *and* G. R. PARANJPE, Bombay.

The experiments are carried out with a view to establish a laboratory method for measuring sound transmission and absorption and reflection coefficients of certain materials. The reverberation method is well known, but that can be carried out only on a large scale.

An electrical oscillator and a microphone receiver are employed throughout. The intensity of the sound received in the microphone is measured through suitable amplification by means of a valve-voltmeter. The experiments are divided into two parts. In one the reverberation method is employed wherein decay curves for the sound are plotted out and in the other sound is received on the microphone through known thickness of different materials. The apparatus consists of a long wooden box internally lined with thick felt, and divided into two compartments. The sounding portion is well equipped with buffles and is maintained at constant volume.

Experiments can be carried out to measure the transmission coefficient of different substances and to study the effect on the transmission coefficient of the frequency of the sound.

53. On the condensation of liquid drops on dust nuclei and the estimation of the size and number of dust particles in air.

Y. G. NAIK *and* G. R. PARANJPE, Bombay.

Work on water drops was reported last year and the work has been now carried on in greater details also with a view to be able to measure with the number and size of dust nuclei. The method employed is that of measuring the corona rings.

(1) With increasing number of dust particles, the liquid drops become smaller and reach a limiting size. The graph of the number of dust nuclei and the size of the condensed drop, is hyperbolic (other conditions remaining the same).

(2) Number of dust particles in a given specimen of air can be calculated in the following manner. The air in the flask was made completely dust free by making a series of expansions, no fresh particles being allowed to enter. From the size of the drop and the quality of liquid condensed the number of particles removed every time is calculated. By summing up all these numbers, the total number of particles existing originally can be obtained.

(3) Experiments were performed with alcohol and the change in the size of the drop with different expansion ratios and different temperatures were studied. The nature of these variations is the same as that of water.

The size of the drop reaches a higher limiting value beyond a certain expansion ratio. Fall of temperature increases the size of the drop.

54. Studies in scatting of light through some organic esters.

K. S. Savanur *and* G. R. Paranjpe, Bombay.

A systematic study of Raman scatting through some organic esters is undertaken. The esters chosen are formates and acetates.

The unsymmetrical broadening of the incident radiation by molecular diffusion at the middle of the liquid observed by Cabannes is being repeated and the results taken both with a Lummer Plate and an Etalon.

55. A physical method of estimating Fe(ous) and Fe(ic) formed by the oxidising actions of potassium dichromate and potassium permanganate.

P. Y. Deshpande *and* G. R. Paranjpe, Bombay.

A new method based on the measurement of the Absorption Spectra of Solution has been used for estimating the extent of Oxidation of Ferrous Ammonium Sulphate caused by Potassium dichromate and Potassium permanganate. A graph can be drawn in which the wave-length at the absorption edge at constant thickness is plotted against known percentage of Fe(ous) and Fe(ic) formed at different stages of the oxidation. It has been shown that this graph can be used to directly indicate the percentages of unknown quantities of Fe(ic) and Fe(ous) form the knowledge of the wave-length at the absorption edge at constant thickness.

The actual quantities of Fe(ous) and Fe(ic) can also be determined by means of another graph plotted between the molalities and the wave-length at the absorption edge at constant thickness. Results thus obtained are in fair agreement with those obtained by chemical method.

The method, it is expected, will also be helpful in determining the oxidizing powers of Dichromate and permanganate, when they act jointly on the Ferrous salt. The part is under investigation.

56. Electrical conductivities of the liquid amalgams of the alkaline-earth group.

V. S. Patankar *and* G. R. Paranjpe, Bombay.

The nature of the liquid amalgams of alkali-metals has been investigated with reference to a number of physical properties, but little work is done in regard to the amalgams of the alkaline-earth group.

The electrical conductivities of the Barium amalgams is studied in the first instance. The result indicates that there is a continuous drop in the conductivity with the concentration of Barium in the amalgam. In the case of the sodium and potassium amalgam the conductivities are also known to decrease while in the case of Lithium the conductivity increases with the concentration.

Side by side with this an investigation is in progress with a view to examine the homogeneity and stability of alkali and alkaline-earth amalgams.

57. On the instability of the Atmospheric Electric Field in the neighbourhood of the Evening maximum.

A. V. R. Telang, Bangalore.

Several records of atmospheric electric field reveal characteristic instability of the field at about 19–20 hours, the time of the principal maximum. The instability consists in either (1) A sharp uprush followed by equally sudden return, forming needle shaped peak; (2) Gradual rise followed by sudden collapse and thereafter gradual fall; (3) A greater

collapse, followed by partial recovery, forming depression; (4) Depression deep, potential often becoming negative, characteristic of slight rain, but without recorded rain; or (5) as in (4) but rain recorded by pluviogram or sight at the exact time.

Frequent occurrence of such instability indicates that factors raising potential and those causing inversion are closely related. Among the first are reduced conductivity through loading of ions by moisture as temperature is rapidly falling, and the sinking to earth of loaded negative ions. Moisture is known to first condense on negative ions, which would therefore sink first. If this be followed by loading and precipitation of the positive ions the field will collapse. The speed and degree of collapse will depend on the rapidity of removal of ions which depends on the size of the drops. With small drops effects 1 and 2 above may occur; with larger drops effect 3, and with drops forming invisible or visible drizzle we get the effects 4 and 5 characteristic of precipitation.

58. Electric conductivity of the Atmosphere at Bangalore.

A. V. R. Telang *and* A. Padmanabha Rao, Bangalore.

For some years past determinations have been made of the Potential Gradient of the Atmospheric Electric Field, and some of the results published (vide *Indian Journal of Physics*, vol. 5, part 7, November, 1930, pp. 755-767: 'Atmospheric Electric Potential Gradient at Bangalore' by A. Venkata Rao Telang).

Determination of the electric conductivity of the air has been undertaken as an extension of the work on Atmospheric Electricity at Bangalore.

The method employed is Elster and Geitel's dissipation method, using a stretched wire as dissipator. An electrometer of the gold leaf type is used. The insulators for the electrometer and the dissipating wire are of the heated quartz type, *Loc. cit.*, p. 760. The dissipating wire is of copper with a bare polished surface stretched between two insulators in a place open to outside breeze, but shielded from the Earth's electric field. The negative and positive conductivities are separately found by charging the dissipator positively and negatively respectively. The following are some of the results obtained.

Date.	Time.	Conductivity in Electro-magnetic Units.			$q_\lambda = \frac{\lambda+}{\lambda-}$
		$\lambda+$	$\lambda-$	$\lambda=(\lambda+)+(\lambda-)$	
3rd Sept. 1931	2 P.M.	·2572 κ	·2829 κ	·5401 κ	·91
12th Sept. 1931	4 P.M.	·2619 κ	·2227 κ	·4846 κ	1·13
18th Sept. 1931	12-30 A.M.	·4413 κ	·6297 κ	1·0711 κ (raining)	·70
20th Sept. 1931	11-40 A.M.	·2174 κ	·1636 κ	·3811 κ	1·33

κ=11·31 E. M. Units (Ohms. Curt.)

59. A new rotating Commutator.

A. V. R. Telang, Bangalore.

A ring of thin ebonite sheet is mounted on a Phonic wheel (See Pye and Co.'s catalogue). Fixed to the ring are two sets of radial sectors *A* and *B* of metal sheet, uniformly spaced. The sectors *A* are between the sectors *B* and nearer the centre of the ring, such that the outer thirds

of sectors *A* and the inner thirds of sectors *B* lie on a common circle. Three insulated metal brushes are mounted in a radial line to touch these sectors as the ring rotates, so that brushes 1-2 and 2-3 are alternately shorted through the sectors *A* and *B* respectively.

The arrangement can be used to charge and discharge condensers or other similar purposes. Using further similar brush sets at other positions on the ring we can obtain a number of similar commutating effects either in phase or with some phase difference.

Advantages of the arrangement :—

1. Absolutely steady and fixed speed, governed only by the tuning fork employed.
2. Unaltered speed as long as required, and obtained whenever wanted and low power consumption.
3. Speed determined accurately and once for all with counter and bell.
4. Different frequencies obtained with rings having suitable numbers of sectors.
5. Reliable contacts of sufficient duration ensured through brushes rubbing on metal surfaces.

60. A Statistical Analysis of the height of the Brahmani River at Jenapore.

P. C. Mahalanobis, Calcutta.

The daily readings (numbering 4722) of the gauge at Jenapore for the period 1875-1929 for the months of July, August, and September have been analysed in this paper. The secular change (which was found to be extremely small) has been calculated separately for each month, as well as for the whole monsoon period. The frequency distribution of the height of the river has been studied in detail, and has been graduated by Pearson curves (Type I and Type III) The probability of occurrence of any assigned flood level in a given number of years has been calculated, graphically for the graduation by a Type I curve, and with the help of Incomplete Γ-functions for a Type III curve.

61. Temperature distribution in the atmosphere over India during different periods of the year.

K. R. Ramanathan *and* K. P. Ramakrishnan, Poona.

Soundings of the upper air over Poona and Hyderabad during the last three years have provided us definite information regarding the temperature and humidity in the atmosphere over these places. This, when combined with the results of sounding balloon observations at Agra made in previous years and observations made from aeroplanes at Karachi, Quetta and Peshawar enable us to obtain a general idea of the distribution of temperature in the atmosphere over India in different parts of the year. Observations of wind at different heights obtained from ascents of pilot balloons confirm and supplement the conclusions. Some outstanding results may be indicated :—

(1) During July and August, the atmosphere over Agra is warmer than that over the Deccan at all levels up to about 15 km—the mean difference of temperature being a maximum of about 7°*C* at a height of 10 km. Temperatures over Batavia are lower than those over the Deccan.

(2) Conditions are markedly in contrast in the winter. In the period November-February, the temperatures over North India are lower than those over Poona up to 13-14 km. and above that level, higher.

(3) The semi-permanent anticyclone over the central parts of India during the winter and early summer shows itself in the temperatures over Poona as a well-marked region of small lapse-rate between 2 and 4 km.

The changes that take place during the transition season are also described. The bearing of these results on the general circulation of the atmosphere in India and its neighbourhood is discussed.

62. The surface and upper air structure of depressions of the Indian Monsoon period.

K. R. Ramanathan, Poona.

A detailed analysis has been made of three typical depressions of this season; and the system of circulation that gives rise to them, the properties of the 'air-masses' that come together during their formation and growth and the nature of the 'fronts' that are developed are studied.

63. Surface-tension of the Different Dilutions of Boy's Soap Solution.

L. D. Mahajan, Patiala.

This paper reviews briefly the two improved methods of finding the surface tension of the soap solutions and also the relation of the surface tension of the soap solutions with their concentrations.

The results are obtained by two methods namely the Warren's Surface tension Balance method and the Weighing method. In all the observations, the Boy's Soap solution and its various Dilutions are used.

It is found that the surface tension of the soap solutions is not independent of the strength of the soap solution (i.e., the strength of the sodium oleate in the solution); and it throws much light on the results obtained by Lord Rayleigh; M. G. White and J. W. Marden; A. L. Narayan and G. Subrahmanyam; P. L. Du Nouy and others.

Further it is found that the surface tension decreases with the increase of concentration in the beginning but after reaching a certain minimum it increases with the increase of concentration. The possible cause for the marked minimum is also explained.

The curves are also drawn showing the above relation clearly.

64. The Effect of Light on the Surface Tension of Boy's Soap Solution.

L. D. Mahajan, Patiala.

The aim of this paper is to study the action of light on the surface tension of the soap solutions, in details.

With the aid of Surface tension balance and Weighing methods; it is found that the decrease in surface tension is a function of time for which the soap solutions is kept in light and not a mere function of time as found by P. L. Du Nouy. The dark time, i.e., the time for which the soap solutions are kept in a very dark and cool place, has no effect on the surface tension of the soap solutions. The possible reason found is some chemical action and not mere absorption in the surface layers.

The methods are also described in details. The curves are drawn showing the relation of surface tension of Boy's soap solution dilutions with time, from the results obtained by the above two methods.

Further, all the tables show the same results and hence the above work also confirms the theory and the use of the surface tension balance for finding the surface tension of the solutions.

65. After-glow in Silica discharge tubes.

D. B. DEODHAR, Lucknow.

It is observed that a strong after-glow persists in discharge tubes made of silica. The intensity of the after-glow depends upon the pressure of the gas in the tube, being the strongest at pressures in the neighbourhood of ·06 to ·1 mm. of *Hg*. Tubes with *H*, *O* and *N* were tried and all of them gave equally intense after-glow. The tubes were excited by a small induction coil for two minutes and then were disconnected. The after-glow was of a greenish colour which lasted for about an hour. Such a long duration of the after-glow appears to be a remarkable phenomenon. If the glowing tube is observed in a good dark room it is seen that the glow consists of surging motions which keep on showing themselves. Direct vision spectroscope shows the existence of bands in the green and the blue region of the spectrum. An attempt to photograph these bands with the large spectrograph with hundred hours exposure was not successful. Investigations in that direction are continued with still longer exposures.

66. Colour variations in the low voltage glow of hydrogen.

A. C. BANERJI, Lucknow.

(Communicated by Dr. D. B. Deodhar.)

Observations were made on the change in colour with changes in voltages, currents and pressures in a hydrogen discharge tube. A specially constructed tube of quartz was employed, which could be evacuated to pressures varying between ·02 mm. and upwards. It consisted of an anode of thin nickel plate and an oxycathode of platinum. The cathode was heated by a current from a series of secondary cells and a positive voltage was applied to the nickel plate. All the impurities were carefully removed by washing the tube several times with hydrogen obtained by heating the palladium tube inserted into the side of the discharge tube.

It was observed that the glow made its appearance on the anode at 30 volts and at a pressure of ·03 mm. of mercury. The most remarkable feature of the glow was its colour change as the pressure and the anode voltage were varied. At a pressure ·4 mm. and upwards it was found that the glow had sky blue colour which only changed in intensity with the voltage, and at pressures lower than ·4 mm. the glow at first appeared blue but it became pink by increasing the anode voltage and green when the voltage was further increased.

Spectroscopic observations of these glows showed distinct prominence of the lines of the region whose colour was equal to that of the glow. This means a particular pressure and voltage favours the excitation of certain group of lines and therefore such group of lines can be easily analysed. This matter is being further investigated.

67. Dielectric coefficient of Sulphur Hexafluoride.

G. GUNDU RAO, K. L. RAMASWAMI, *and* H. E. WATSON, Bangalore.

By employing the heterodyne beat method at high frequency, the dielectric coefficients of gaseous sulphur hexafluoride were determined at the temperatures $+25°$ and $-80°$. The values of $(e-l)\ 10^6$ reduced to equal densities at *N. T. P.* are respectively 2217 ± 4 and 2215 ± 6. These results indicate that the sulphur hexafluoride molecule possesses no dipole-moment.

The value of $(e-l)\ 10^6$ calculated from the refractivity (Prideaux, *J. C. S.*, 89, 316, 1906) is 1566 quite in disagreement with the above observed result. On the other hand the refractivity calculated from the values $S = 550$ (C. Cuthbertson, *Phil. Trans. Roy. Soc. Proc. A.*, 204, 323,

1905) and ($3F_2$=585 (*ibid.*) 205, 319, 1905) gives for $(e-l)$ 10^6 the value 2232 which agrees with the observed results.

68. Studies in Electric moments. Part I.

M. A. GOVINDA RAU *and* B. N. NARAYANASWAMY.

A sensitive alternating current bridge of the Scherring type has been set up, with a 3*NF* valve followed by a Moullin type volt-meter as a detector. With this apparatus and a new type of condenser for containing liquids the dielectric coefficients of a number of solutions in benzene can be measured accurately at different temperatures, and the electric moment of the solute molecule calculated from the change of molecular polarisation with temperature.

The moments of a series Pyridine, α, β and γ picolines and piperidine have been studied so far. Further work on other derivatives of pyridine is in progress.

69. Supersonic Velocity in Air.

S. K. KULKARNI JATKAR *and* H. E. WATSON, Bangalore.

Most of the results obtained by us till now show that the apparent wave-lengths in air at 50,000 cycles is 753 meters at 25°*C* which is double that of ordinary. The observed normal values are due to the crystal acting as an acoustic doublet. The main facts in support of this are:—

(1) The effect of covering the radiator face with a thin glass plate was to cut down the radiation from the back and enhance that from the front, the resulting wave-lengths especially nearer the crystal being twice that of ordinary.
(2) The crystal was brought into oscillation only when the distance of the reflector was multiple of double the normal half wave-lengths when on the critical side of oscillating.
(3) The effect of putting an aperture on the tube was to partly filter off the back radiation and give double the wave-length.
(4) The values of half wave-lengths and the corresponding extent of resonance were high and low, the effect being marked with greater amplitude of the oscillating crystal.
(5) The observed results are not due to the crystal vibrating at a lower or sub-fundamental frequency, as a careful search for this was made by a heterodyne receiver.

The experiments are being extended to cover lower frequencies and higher temperatures upto 1,600°*C* with a specially designed molybdenum wound furnace.

70. On the measurement of absorbtion coefficient of materials in Auditoria.

S. KALYANARAMAN, Madras.

The work was undertaken in connection with an acoustic survey of certain auditoria in Madras. The author met with certain specimens of coir mats and cushions which are so commonly used in our public halls, and for which absorbtion data are not available on account of their local origin. The absorbtion coefficient for these materials have been measured by the author by the method of stationary waves using a tuned hot wire microphone. The arrangement adopted is generally that of E. T. Paris (*Proc. Phy. Soc.*, 1927) with certain modifications. The data obtained from the experiments were quite satisfactory and fitted in very well with the actual performance of these auditoria.

71. Some Theoretical Aspects of Negative Circuit Constants.

LAL C. VERMAN.

A brief review of literature on devices having negative resistance is made and it is pointed out how it is possible to obtain negative capacitance and negative inductance. New names are proposed for negative constants, i.e., nesistance, napacitance, and ninductance. A system of a series of circuits is described by means of which it is possible to obtain impedances proportional to $\pm(j\omega)^n$, where ω is the cyclic frequency, n any positive or negative integer, and j is $\sqrt{-1}$.

It is proved that for transient states the circuits furnishing ninductance and napacitance would behave just as they do under steady state conditions that is as pure negative constants, provided the nesistance which forms an essential part of these constants is itself a pure negative resistance, which it invariably is in practice. Solutions of a few differential equations for circuits containing negative constants are presented. Good many of these lead to increasing transient currents, unlike the familiar decreasing transients so well known in connection with circuits containing the conventional positive elements. It is pointed out how these transients are prevented from going to infinity by virtue of the limited range over which the negative character of the circuits exist

72. Vertical Oscillations of a test tube float. A method of determining 'g'.

V. APPA RAO, Triplicane.

The vertical oscillations of an ideal test tube float, in any liquid can be shown to be simple harmonic. The periodic time thus calculated for the ideal case requires two corrections: due to –

(1) the viscosity of the liquid in which the float moves;

and (2) the increase in inertia, which is due to the distortion of the lines of flow round the hemispherical end of the float.

The damping correction was calculated by observing the logarithmic decrement. The effective increase in mass due to inertia is a constant for a given float and was calculated for the hemispherical end of the float from the time of vertical oscillations determined experimentally.

Experiment has shown that the damping correction amounts to only one in thousand and that the inertia correction comes to about 4 in hundred.

The value of 'g' was calculated in the case of four different floats. The mean value was found to be 979·0 cm. sec.^{2} The highest value obtained was 984·2 and the lowest 974·0. Three other values were near 979. The accepted value is 978·3 cm. sec.^{2}

73. Experimental study of the duration of contact of an elastic hammer striking a damped pianoforte string.

MOHINIMOHAN GHOSH, Calcutta.

A detailed study of the loss of energy during impact of hard, elastic and felt hammers has already been made, where a new model of an elastic hammer has been given.

In this paper the variation of the duration of contact for, one hard, two elastic hammers of the above model, and a felt hammer, each being of same weight has been studied photographically, for different striking distances of a string of length 600 cm. The time record on the photograph has been made by a fork of frequency 200. It is found that in all cases the duration of contact varies discontinuously as the striking distance

increases. In studying the effect of the elasticity (E) of the hammer on the duration of contact when striking at the mid-point, it is found that, at first the duration of contact increases, then attaining a maximum value, slowly decreases, and tends to be a constant as E is further increased. As regards the effect of the radius of curvature (r) of the surface of contact of the hard hammer striking at mid-point it is found that the duration of contact for lower values of r is constant, then slowly increases as (r) is increased and finally becomes constant for large values of (r). The damping of the string is found to have little effect on the duration of contact as following from our theory. In the case of the felt hammer it is found that the duration of contact multiplied by the fifth root of the velocity of the impact is constant as required by Hertz's theory of impact.

74. General theory of the pianoforte string.

MOHINIMOHAN GHOSH, Calcutta.

The theory of the pianoforte string struck by an elastic hammer which may be considered as weightless spring backed by a hard hammer has already been developed by Kar and the present writer. The above theory is applicable for mid-point only.

In this paper the writer has considered the problem in a general way. The string is supposed to have damping. The impact is considered at a finite distance (a) from one of the fixed ends of the string, the other end being at infinity. The duration of contact has been divided into a number of epochs $0, \frac{2a}{c}, \frac{4a}{c}$, etc., where c is the velocity of transverse wave along the string. The displacement of the struck point and other points of the string during contact has been obtained. The expression for the pressure during second epoch has been found to be

$$F_2=2\rho Vc\left[\left(1-\frac{km}{4\rho c}\right)\left\{e^{-qt}+e^{-q\left(t-\frac{2a}{c}\right)}\cdot\left(1-q\left(t-\frac{2a}{c}\right)\right)\right\}-\frac{1}{1+\frac{kT_1}{Ec}}\left\{e^{-pt}+e^{-p\left(t-\frac{2a}{c}\right)}\cdot\left(1+p\left(t-\frac{2a}{c}\right)\right)\right\}\right]$$

where

$$q=\frac{2\rho c}{m}\left(1-\frac{km}{4\rho c}\right),\quad p=\frac{Ec}{2T_1}\left(1+\frac{kT_1}{Ec}\right),$$

k the coefficient of damping, T_1 the tension, ρ the line density of the string, E the elastic constant, m the mass of the hammer, V the velocity before impact.

The general case of a finite string of length (l) struck at any point has been treated. The expression for the duration of contact struck by a hard hammer at the mid-point of a damped piano-string is shown to be

$$\frac{\phi}{\theta}=\frac{1}{2}+\frac{1}{4}\frac{m}{m_1}\left(1-\frac{km}{4\rho c}\right)\left\{1+\tfrac{1}{2}e^{-\frac{2m'}{m}\left(1-\frac{km}{4\rho c}\right)}\right\}$$

if the hammer leaves the string during the second epoch (where $m'=l\rho$ and $\theta=\frac{2l}{c}$). Further it has been shown that Kaufmann, Das, Delemer, and other theories are only particular cases of the above.

75. Note on Kramer's theory of X-ray absorption.

A. GANGULI, Chandernagore.

In an important paper Kramers deduced an expression for the X-ray absorption coefficient in the following form:

$$\alpha_T = \frac{m^2 v^2 c^2}{2ah^2 v^2} \beta_v,$$

and evaluated β_v from other considerations.

By considering an equilibrium between free and bound electrons, the present author along with K. C. Kar [*Z.f. Phys.* 62, 510 (1930)] obtained the Saha equation as well as Richardson's law for thermionic emission for non-degenerate and generate cases. Similar considerations have been applied in the present case in which an equilibrium between the number of electrons having velocity between 'v' and '$v+dv$' and the number of quanta (which are responsible for electrons) that are absorbed by electrons is considered and thus the above expression is deduced. It is pointed out that the factor ah^3 follows directly from the calculation of number of bound electrons. 'a' is however equal to $n(n+1)$, 'n' being the principal quantum number. It is further mentioned that the bound electrons absorb radiation, which result in the escape of free electrons. This suggests a mechanism of photoelectric emission.

76. On the total photoelectric emission.

A. GANGULI, Chandernagore.

The value of the absorption coefficient obtained from a previous paper (see preceding note on Kramer's theory of X-ray absorption) is multiplied with the radiation density, the number of atoms per sq. cm. and the emissivity E ($=1$ for black body). The following expression is obtained by integration

$$n = \int n\alpha_T(E) \frac{8\pi v^2}{c^2} e^{-\frac{hv}{kT}} dv.$$

The number of electrons obtained by dividing the above expression by hv (since an electron is emitted by the absorption of a quanta according to Einstein's law) multiplied by the charge 'e' gives in the first approximation the value of the total photoelectric current in the following form

$$i = N(E) . \frac{512}{3\sqrt{3}} \frac{\pi^5 N^4 e^{11} mkT}{ah^7 c^3 n^3 v_0} e^{-\frac{hv_0}{kT}},$$

where N is the atomic number, 'n' the quantum number and v_0 is the threshold frequency. Thus

$$i = A . Te^{-\frac{b}{T}}$$

and the curve obtained by plotting log $\frac{i}{T}$ against $\frac{1}{T}$ gives straight lines in most cases. From experiment it is found that 'i' increases with the atomic number of the metal which line with the above theory. It may however be pointed out α_T may differ for the electrons ejected from different orbits as follows from wave-mechanics.

77. On paramagnetism.

A. GANGULI, Chandernagore.

Paramagnetism is considered to be due to those valency Electrons that are pulled out to the surface from the various magnetic orbits 'm',

when the field is introduced. An equilibrium similar to that in the case of thermionic emission (Kar and Ganguli *ZS. f. Phys.*, 62, 510, 1930) between free and bound Electrons is considered, and the ionisation potential is replaced by the magnetic potential 'Em' all values of which for $m=+j$ to $-j$ being taken. Using the familiar relationships for Em, μ, j and g, we obtain the following expression for the paramagnetic susceptibility for non-degenerate case

$$\kappa_p = Na + Ng^2 j\,(j+1)\,\mu^2/3KT.$$

where Na is due to diamagnetism. This formula is similar to those obtained by Pauli (*ZS. f. Phys.*, 41, 81 (1926)) and Van Vleck (*Phys. Rev.*, 31, 587 (1928)). For degenerate case, also we obtain Curie's law, indicating that paramagnetic susceptibility is dependent on temperature, even up to very low temperature. This is in line with the experiments of Kammerling—onnes and others. A similar expression has been deduced by Howells (*Phil. Mag.*, 10, 698 (1930)) as well.

78. Studies in the Barkhausen effect.

V. D. DABHOLKAR, Bombay.

An apparatus has been set up to study the Barkhausen Effect in Steel specimens, using an Oscillograph.

It is found that the discontinuities vary in number and size from specimen to specimen and show marked variations according to the position of the specimen on the magnetisation curve.

A noteworthy point is, that with each specimen, there appears to be a critical value of the field at which the first large discontinuity occurs.

The volumes associated with one discontinuity have been calculated and show a remarkable constancy.

79. Current rectification at metal contacts.

S. P. CHAKRAVARTI *and* S. R. KANTEBET.

Six different contacts of dissimilar metals namely Cu-Fe, Cu-Sn, Sn-Zn, Zn-Fe, Bi-Fe, and Pb-Sn were studied for their rectifying properties. As far as possible, small lengths of cylindrical rods with circular section were used. Their tips barely touched each other producing an imperfect contact at which rectification was found to take place best.

In all cases, static characteristics showed that when the thermo-positive element was given a positive polarity, the characteristic reached saturation conditions, while with reversed polarities the contact behaved like an ohmic resistance. On the positive side the characteristic starts with being straight for a distance and then with a sudden rise, reaches saturation.

The effect of varying contact area, pressure, and temperature were next studied. Rectification improved with diminution of contact area, point to point contact being the best. The rectification vanished on either side of the limiting added weights 1 to 2 gms. External heating of contact renders the characteristic almost a straight line up to the saturation bend.

An attempt is made to explain the rectifying property by assuming that a thermo e.m.f. develops at the contact and that the resistance of the contact itself varies with terminal voltage.

80. Negative attenuation of electromagnetic waves at broadcasting frequencies.

S. R. KANTEBET.

Contrary to the accepted theory of radio wave propagation where the inverse distance law of field strength variation holds good, in the

course of the last few years it has been observed that at distances from the transmitter there is often observable a strength of signal much higher than could be explained according to the classical theories of electromagnetic wave propagation. Instances thus far reported from England, Australia and Sweden refer to longer wave and close quarter observations. The present paper draws attention to signal augmentation instead of attenuation at broadcast wave-length and at several hundred miles distance from the transmitter. From the topography of the land over which this transmission passes, it is suggested that such abnormalities are due to interference between the direct and the sky ray.

81. Formation of standing waves on wires.

AIJAZ MOHAMMED *and* S. R. KANTEBET.

The classical method of determining radio frequencies by the formation of stationary waves on Lecher wires takes no note of the irregularities in the wave form of current distribution. Unless the terminal conditions are definite and the length of lines some integral multiple of the wave-length to be determined, measurements become unreliable. The paper deals with a study of the alterations in the wave form as the length of lines is varied by small fractions of a wave-length. The resulting complex distributions are shown by way of a number of resonance curves.

82. Depth of modulation in modulated self-oscillator.

V. V. SATHE, T. S. RANGACHARI, *and* S. R. KANTEBET.

The strength of signal in broadcast reception is proportional among other factors to the depth of modulation of the transmitted carrier wave. The depth of modulation that may be obtained from a grid-modulated self-oscillator triode is very limited. All high power hundred per cent. modulated transmitters use elaborate circuits consisting of drive and modulated amplifier to obtain increased modulation. In the present experiments a pentode was used with the oscillatory circuit between the plate and the screen-grid. Experimental results show that 60 per cent. undistorted modulation is easily obtained. Even at this modulation, the carrier wobble usually experienced on oscillatory triodes is not perceptible. Comparative performance curves taken at various modulating frequencies show that self-oscillating multi-electrode valves could conveniently replace the drive plus to modulated amplifier stages of deeply modulated transmitters.

83. Effect of transverse magnetic field on graphite-iron couple, etc.

V. I. VAIDYANATHAN *and* MUKAND LAL, Lahore.

Experiments were made to study the effect of transverse magnetic field on the thermo e.m.f. generated in a graphite-iron couple. A graphite crystal was cut parallel to the crystallographic a-axis and pressed against an iron wire which formed the junction. This was heated electrically and the temperature recorded pyrometrically. Cold water was circulated round the cold ends. In the first stages the direction of the current was from iron to graphite at the hot junction but at 390°*C* the direction of the current reversed. The couple has the neutral point at about this temperature. When transverse magnetic field was applied there was an increase in the thermo e.m.f. up to the neutral point whereas after the neutral point, the transverse field caused a decrease in the thermo e.m.f.

The following results were obtained.

Temperature C	E.M.F. (10^{-6}) Without field.	E.M.F. (10^{-6}) With field (1500 G)
83	76	80
191	200	218
308	255	303
354	82	115
428	133	105
492	500	453
561	928	820

Due to experimental difficulties it was not possible to go beyond this temperature with this couple, though the object was to go up to the Curie point of iron

A platinum-iron couple was tried in the magnetic field. The thermo e.m.f. generated decreased at first under the influence of the field, but at the Curie point of iron the effect vanishes. This effect and its disappearance at the Curie point, are of considerable interest in the theory of ferromagnetism.

84. Vibrations of a circular plate of variable thickness.

J. GHOSH.

The author has discussed the free vibrations of a circular plate of isotropic material, either complete or annular, whose thickness at any point is a function of the radius.

85. On the passage of a charged particle through a double array or 'avenue' of alternately positive and negative charges.

SATYENDRA RAY, Lucknow.

It can be shown that the particle will move with its velocity alternately accelerated and retarded, or will travel with alternately positive and negative rotational velocity about its axis perpendicular to the plane of the avenue, according to the disposition of the charges in the avenue.

86. Planck's '$h\nu$' as an 'exchange ratio'.

SATYENDRA RAY, Lucknow.

When a vibrating particle stops, owing to transfer of its energy to a medium in which it sets up 'waves', it can be shown that if the wave velocity is constant the waves are geometrically similar and that before a vibration of the source stops $k\nu$ or $h\nu$ wave-lengths in the medium shall be generated. One frequency of one particle is therefore equivalent to the same frequency in $k\nu$ or $h\nu$ shells of thickness λ in any exchange of energy between source and medium.

87. A simple parallel plate type of apparatus for finding Radiatio Constant.

SATYENDRA RAY, Lucknow.

The Denning's apparatus for determining σ reported to the Nagpur session, 1931, was further modified by making the areas of the radiating

and receiving surfaces absolutely equal in a parallel plate condenser type of apparatus. The heater forms the bottom of a cylindrical vessel resting on the parallel plate below it, and thermally insulated from it by three cleats. Two methods of calculating the value of constant were employed, one at any temperature before the final fixed temperature is attained, the other when at the final temperature equilibrium is attained between the heat gained by radiation from the radiator and the heat lost from the receiver's undersurface by Newton's law of cooling. As the error in the two cases can be easily seen to be complementary and not independent of each other, a very good value of the constant is found by taking the 'mean' of the results found by the two methods. This result differs from classical experimental values by less than 2 per cent.

88. On a theory of catalytic action.

SATYENDRA RAY, Lucknow.

$\oint dQ$ for a thermodynamic cycle is not zero. It must therefore mean that a change of state takes place of the working substance during the cycle. In this continuous change of state during successive cycles the work done by the cycle can be utilised either to help or retard a chemical reaction and the working substance would behave like a 'catalytic agent'.

89. The isentropic for a substance obeying Grueneisen's Law.

SATYENDRA RAY, Lucknow.

It is shown that a substance for which the ratio of the coefficient of expansion to the specific heat is constant independently of temperature, it is not dQ/T, but dQ itself, that defines the change of entropy. The equation of the isentropic is derived.

90. Calorimetry with volume of solids with the help of Grueneisen's Law.

SATYENDRA RAY, Lucknow.

Grueneisen's Law states

$$(l/v)\ (dv/dT)_p = G\ (l/m)\ (dQ/dT)_p$$

This leads to

$$v = v_0 e^{(G/m)Q}$$

Defining temperature by the solid itself through the equation

$$v = v_0 e^{\alpha t}$$

we get

$$(G/m)Q = \alpha t + \beta$$

which determines the 'heat content' itself in terms of the temperature. Also the specific heat is given by

$$\sigma = (\alpha/G).$$

91. Wiedemann-Franz's Law as composition of the separate identity (or atomicity) of molecular conductivities, thermal as well as electrical.

SATYENDRA RAY, Lucknow.

From an argument given in the paper on the colloidal theory of molecular weights, submitted to the Chemistry Section of the Congress in 1931, it was found the two conductivities would themselves be constant.

This was tested by two teachers of the Isabella Thoburn College, Lucknow, Miss S. Ghosh and Miss J. H. Inglis, who found that they were atomic and not constant. The values of the Wiedemann-Franz's ratio were then calculated from the latest values in the physikalische chemische Tabellen and found to be not constant but also atomic to exactly the same extent as the two component conductivities themselves. The atomicities cannot be explained away as 'errors' by any means.

92. Atomicity of lowering in the solidification point of solutions of metals in metals.

SATYENDRA RAY, Lucknow.

From the same tables solutions in 9 metal solvents of 22 metal solutes were examined for a Roult's Law analogue. An atomicity can be easily seen. The 'atom' of the Gefrierungspunktsniederung for the different solvents were to one another as 1 : 3 : 1 : 4 : 10 : 3 : 5 : 3 : 4.

93. On the solution of the diaphantine equation $n_1^2 + n_2^2 + n_3^2 = k$.

SATYENDRA RAY, Lucknow.

In connection with a physical problem the solution of the above equation was wanted. In the absence of any method known to the author 2 eight-valued, 2 seven-valued, 17 six-valued, 29 five-valued, 55 four-valued, 93 three-valued, 169 two-valued together with hundreds of one-valued solutions between them were found by trial. Thus : 374 is the sum of the squares of 6, 7, 17 : 5, 5, 18 : 2, 3, 19 : 1, 7, 18 : 2, 9, 17 : 7, 10, 15 : 3, 13, 14 : 6, 13, 13, whilst 446 is the sum of the square of 6, 7, 19 : 2, 9, 19 : 1, 11, 18 : 6, 11, 17 : 10, 11, 15 : 9, 13, 14 : 5, 14, 15 : and 1, 2, 21.

94. The Meaning of Pressure.

SATYENDRA RAY, Lucknow.

Pressure is dimensionally force per unit area, energy per unit volume, and energy streaming into the surface, per area, per time, with velocity v. In kinetic theory pressure is dimensionally

$$p = (N/V)mc^2.$$

This is very akin to the heat content per volume. The specific heat is dimensionally $(1/\rho)(dp/dT)$, so that either an infinite value of ρ, as for gases, at $0°A$ or zero value of the vapour pressure variation with temperature as for solids, will make the specific heat equal to zero at absolute zero. For a constant value of specific heat for gases N/V must be a constant, that is the Avogadro's number must be proportional to the volume or, what is the same thing, to the absolute temperature.

95. Association of water in solutions of strong, weak, and non-electrolytes.

I. RAMAKRISHNA RAO, Patna.

The structure of the Raman Band for water was studied in solutions of strong and weak electrolytes as well as of non-electrolytes. The theory proposed by the author explaining the changes in the structure of the band with increasing temperature and with increasing concentration of electrolytes is extended to make an estimate of the changes in the proportion of associated to single molecules of water in all the above types of solutions.

96. The triplet structure of the Raman Band for water and its significance.

I. RAMAKRISHNA RAO, Patna.

On account of the controversy with Gerlach regarding the structure of the water band, a thorough study of the intensity distribution is made of bands arising out of a large number of lines in the visible and ultra-violet regions of the mercury arc spectrum, and its triplet nature suggested by the author confirmed. A study of the polarisation of the band has also supported this view.

An explanation is given as to the origin of the triplet.

97. Performance of parallel plate interferometers made in India.

H. PARAMESWARAN *and* S. HARIHARAN.

The authors have been engaged in making some interferometers of the Lummer parallel plate pattern and the attempt has met with some success. The methods adopted and the results obtained are discussed.

98. A graticle ruling engine.

H. PARAMESWARAN *and* C. S. VENKATESWARAN.

The paper describes a ruling engine constructed by the authors for ruling rizeaus and graticules of great accuracy as required for astronomical and other purposes. Its performance is discussed.

99. An auto-collimation method for the determination of the radius of curvature.

H. PARAMESWARAN *and* C. S. VENKATESWARAN.

In optical and other work a problem often met with is the accurate determination of the radius of curvature of large non-reflecting surfaces in the ground stage. For such work the Focault test method cannot be employed and the spherometer method is not accurate enough. In such cases a pair of interferometer plates are laid side by side on the surface and these are observed by an auto-collimation telescope fitted with micrometer eyepiece and illuminated cross wire. The separation between the two reflected images is measured and used to compute the radius of curvature.

100. An interesting case of vibration in surfacing work on a lathe

H. PARAMESWARAN *and* C. S. VENKATESWARAN.

The authors have observed that when a thin metal plate clamped at its centre is being surfaced on a lathe, the operation becomes noisy and instead of a smooth surface a regular pattern results on the surface. The frequency of the note emitted is found to agree with that calculated from measurements made on the pattern formed showing it to be due to the vibration of the plate.

101. On the canonical reduction of Hermitian forms.

R. VAIDYANATHASWAMY, Madras.

The paper gives a new canonical form for a bilinear Hermitian form, and derives an interpretation of the signature. This is applied to the reduction of polynomial Hermitian forms, and the geometry of the cyclic curves in the complex plane.

102. A generalisation of the theory of parallel transference.

R. VAIDYANATHASWAMY, Madras.

The paper discusses the generalisation of the theory of parallel transference arising from the new differential geometry, in which the metric function is an arbitrary function of position, and of a contravariant vector, homogeneous of dimension 1 in the latter. The bearing of the extension on the isometrical problem in the calculus of variations is also considered.

103. On the general formal principles underlying the new mechanics.

R. VAIDYANATHASWAMY. Madras.

The paper treats of the connection between the ideas and methods of the wave-quantum-mechanics, with the theory of distributive operators.

104. On Simson line.

S. D. SRINIVASAN, Pondicherry.

The locus of the intersection of the simsons of the ends of a chord moving parallel to a side of a triangle is a straight line, viz., the corresponding altitude.

Treat each simson as the line passing through a foot of the perpendicular on the parallel side and the mid-point of the line joining the end with the orthocentre.

The simsons of the ends of any diameter meet at right angles on the nine-points circle.

Treat the simsons as passing through the middle point of the line joining the end with the orthocentre and parallel to the well-known straight line passing through the orthocentre.

105. Any vulgar proper fraction can be expressed as lying between two fractions having any given numerator and their denominators two consecutive numbers; the exceptional case.

S. D. SRINIVASAN, Pondicherry.

106. On the tabular form for comparing two given numbers with the roots of any quadratic equation containing a simple parameter.

S. D. SRINIVASAN, Pondicherry.

107. On the summability of the conjugate series of a Fourier Series.

B. N. PRASAD, Paris.

108. Extension of Jacobi's θ-function formula.

K. VENKATCHALIENGAR, Bangalore.

109. Fine structure of the 4686 line of He^+ in parallel electric and magnetic fields.

D. P. RAY-CHAUDHURI, Calcutta.

In a previous paper (*Zeit. f. Phys.*, 65, 824, 1930) the author calculated the fine structure of the H_α line of hydrogen in parallel electric and magnetic fields with the help of the wave equations of Darwin and Dirac as adapted for the purpose by N. R. Sen. The same is now done for the 4686 line of ionised helium, the method being applicable only to hydrogenic atoms. It is found that a large number of the components have a fine structure, but the magnitude of the maximum separation in most cases is about ·003 Å. Separations of the components parallel to the fields are all within that range, and hence are scarcely measurable. Of the perpendicular components the lines $\pm\omega\pm 3\Delta$, $\pm 2\omega$ and $\pm 2\omega\pm 6\Delta$ have a fine structure separation of ·0115 Å; the lines $\pm\omega$ have ·005 Å, while the lines $\pm\omega\pm\Delta$ and $\pm\omega\pm 7\Delta$ have ·007 Å, All the lines have two components each, the lines $\pm\omega$ alone having three components.

ω and Δ are units of Zeeman and Stark effect separations respectively.

110. Difficulty of Schrödinger's wave equation in the calculation of diamagnetic susceptibility.

D. P. RAY-CHAUDHURI, Calcutta.

Van Vleck (*Phys. Rev.*, 31, 587, 1929) has used the methods of matrix mechanics for the calculation of diamagnetic susceptibilities and arrived at the general result that for substances without initial permanent magnetic moment Pauli's expression (*Zeit. f. Phys.*, 2, 201, 1920) is an upper limit to the diamagnetic susceptibility, there being an additional term which makes a small paramagnetic contribution. Bitter (*Phys. Zeit.*, 30, 498, 1929) arrives at a similar result starting from Schrödinger's wave equation. It is shown that Bitter's success is only apparent and due to his formal method of solution. To the Hamiltonian for an orbital electron without magnetic field he adds a perturbation term linear in H, the magnetic field strength. Analysis shows that the equation is rigidly soluble. Hence the matrix for the Hamiltonian consists entirely of diagonal terms, no terms of the type H_{nk} being present. This makes the additional term in Bitter's expression vanish. It is shown that these non-diagonal terms are present only when we consider the spin of the electron along with its orbital motion.

111. A correction to Laporte and Sommerfeld's formula for the calculation of magnetic moments.

D. P. RAY-CHAUDHURI, Calcutta.

The energy in a magnetic field of an orbital electron with spin is $\frac{eH}{2mc}(L_z+S_z)$, where L_z and S_z are z-components of the orbital and spin angular momenta. Dirac (*Quantum Mechanics*, p. 183) has shown that this may be written as

$$\frac{eH}{2mc}\left\{j_z g+\frac{1}{j^2}(\gamma_y j_x-\gamma_x j_y)\right\}$$

where $\vec{\gamma}=\vec{l}+\vec{s}$ and $g=$ the Landé splitting factor. The additional term is perpendicular to j the resultant angular momentum and makes a contribution when j changes by $\pm\frac{h}{2\pi}$. Laporte and Sommerfeld have calculated the magnetic moment of an ion in the case where the multiplet

separation is small but finite. Analysis shows that their method of calculation neglects the part of the magnetic moment perpendicular to the resultant angular momentum. The multiplet separation being small this part is expected to make an appreciable contribution. The complete expression for the magnetic moment should, therefore, contain a general term of the form

$$\sum_j \frac{\left|\overset{(1)}{H}_{j,j+1}\right|^2}{h\nu_{j,j+1}}$$

where $$\overset{(1)}{H}=\frac{eH}{2mc}\cdot\frac{1}{j^2}\{\gamma_y j_x+\gamma_x j_y\}.$$

This is a paramagnetic term and like the diamagnetic contribution, is independent of the temperature if it is not very low.

The failure of all theoretical formulæ for the calculation of magnetic moments in the case of the platinum and palladium series may be due to this term playing an important role in this case.

An attempt is made to calculate this term in terms of measurable quantities.

112. Equilibrium of a floating triangular prism.

D. N. Sen *and* R. Sharangi, Patna.

The problem of determining the position of equilibrium of a triangular prism with one face not immersed has long been considered. New light is thrown about equilibrium by showing the possible number of positions under various conditions. In particular in addition to established result, it is shown that there may be no position of equilibrium under certain conditions. It is shewn further that for a triangular prism there will always be a position of equilibrium with some face not immersed

113. On Schrödinger's Equation in wave mechanics.

D. D. Kosambi, Benares.

It is proposed to show that equations of the type $\Delta^2\psi+\lambda\psi=0$ can be derived from a Hamiltonian principle, but that equations of the Schrödinger type

$$\Box\mu+\lambda\frac{\delta u}{\delta t}+\phi\mu=0$$

cannot be so deduced.

114. After-glow of mercury vapour.

P. K. Kichlu *and* Mela Ram, Lahore.

Recent work in this Laboratory has shown that the after-glow of vapour distilled from a mercury arc is due to the presence of metastable ionised mercury atoms in the glow, in the state $5d^9\,6s^2\,(^2D_3)$. An attempt was made, by taking three mercury arcs in series giving a total length of the mercury after-glow of about one metre, to photograph the forbidden combination $5d^9\,6s^2(^2D_3-{}^2D_2)$ in absorption, and obtain a crucial test of the hypothesis advanced here. The experiment however did not succeed, perhaps due to the insufficient resolving power of the instrument employed, which in the present instance was a constant-deviation spectroscope.

The authors have identified the line λ 6646·7 which appears in the list of the unclassified lines of ionised mercury given by Naude (*Ann. d. Phys.*, vol. 3, p. 1, 1929), as $5d^9\,6s^2(^2D_3-{}^2D_2)$, and this strengthens the belief that under certain conditions it may be obtained in absorption.

115. Spectra of *AsI*, *AsII*, and *AsIII*.

MELA RAM, Lahore.

The spectra of arsenic have been excited by means of electrodeless discharge and separated into various stages of ionisation by the changes in the lengths of the lines when the intensity of the discharge is varied. The metal was placed in a spherical bulb or a tube according to requirement, and evacuated by means of a mercury diffusion pump. The high frequency discharge was produced with a large induction coil, a spark-gap and a condenser. The ring of light was focussed on the slit of a spectroscope. The bulb seldom needed heating up, as the heat produced by the high frequency currents was enough to volatilise arsenic in sufficient quantity. The method is a very elegant one and has been used before by *L.* and *E.* Bloch. A three-metre concave grating was employed for photographing the spectrum from λ 7000 to 2500. In all over 200 lines have been measured.

116. Spectrum of doubly ionised sodium.

MELA RAM, Lahore.

The lamp described in the proceedings of the last Congress has been used for regulating the distance between two sodium electrodes kept in a high vacuum. A large glass sheet condenser of about ·05 mf. capacity was charged to about 40,000 volts by rectified current, and discharged through the sodium electrodes, and the spectrum was photographed with a small quartz spectrograph. A number of new lines have been measured between λ 1900 and 2400 which are attributed to doubly ionised sodium.

117. On a finite and continuous function which has no mean differential coefficient for any value of the variable.

S. K. BHAR, Calcutta.

About 16 years ago, Professor G. Prasad formulated the problem : Find a finite and continuous function $f\,(x)$ of x, such that for *no* value of x is the mean differential coefficient, i.e.,

$$\operatorname*{Lim.}_{h\to 0} \frac{f\,(x+h)-f\,(x-h)}{2h},$$

existent. (See Prasad's paper in the *Bulletin of the Calcutta Mathematical Society*, vol. 3, 1915, pp. 53-54).

The problem remained unsolved up to now. (See *Encyklopädie der Mathematischen Wissenschaften*, Bd. II. C. 9 b., p. 1092, where Prasad's paper is quoted.)

The object of the present paper is to prove the existence of such functions by actually giving one.

118. Velocity and pressure-distribution over the crest of a submerged obstacle in a stream of fluid of limited depth.

N. K. BOSE, Lahore.

A particular case of this problem has already been solved in *Ann. di. Matematica*, (3), XXI, 237 (1913), though it was suggested by Kelvin in 1904. This is the case of a cylinder submerged at a depth great in comparison to its diameter. But the present case is much more complicated and not amenable to mathematical treatment. The submerged obstacle in this case is a 'Weir' very frequently used in irrigation works. This structure usually begins with a flat bottom, then a upward sloping or a curved approach to a raised crest that might be short or broad. Beyond

this crest there is generally a sloping bed finishing with a flat bottom which is at a lower level than the upstream one. This Weir, short or broad-crested, is used for measuring discharges as water passes over it, by the following equation

$$Q=CB.(H+ha)^{\frac{3}{2}} \quad .. \quad .. \quad .. \quad (1)$$

when Q is the discharge in cubic foot per second, B the length of the Weir, H the head of the U/S water above the level of the crest, ha head due to the velocity of approach, these two quantities being measured at a sufficient distance upstream of the obstacle where its influence is no longer felt, and C a constant. In actual practice C is never a constant, variation being sometimes 30 to 40 per cent. of its theoretical value. That C could not be a constant is inherent in the very nature of the assumption made in deriving the formula, viz.,

$$v=\sqrt{2gh}$$

where v is the velocity of water at any point and h the height of the still-pond-level above this point. This relation never holds inside the fluid medium in the above case.

As the above assumption about the velocity distribution does not hold, the relation (1) is not satisfied. In this paper a pressure-distribution over the crest is assumed and a new law of velocity distribution arrived at.

(2) The 'Exponential Law' of subsoil flow of water on a special case of which the author read a paper in the Punjab Engineering Congress in 1930, holds as a particular case the following generalised form of Darcey's Law

$$u=-k\frac{\delta h}{\delta s}$$

were u is the velocity of water in the direction of δ and h the head at the point. Darcey found a very similar relation that holds only in the horizontal direction, viz.,

$$u=k\frac{h}{l}$$

where l is the length traversed and h the drop in head in this length.

The 'Exponential Law' that was deduced by the author is perfectly general and states

$$\phi=\phi_0 e^{-kt}$$

$$\psi=\psi_0 e^{-kt}$$

where ϕ and ψ are the velocity-potential and stream function at any time t and ϕ_0, ψ_0 corresponding quantities initially. They satisfy the following relations as well

$$\nabla^2 \phi=0$$

$$\nabla^2 \psi=0$$

The following special cases of subsoil water flow has been dealt with.

(1) Subsoil liquid pressure on brickwork foundations.

(2) Flow of water round a tube well.

Section of Chemistry.

President:—PROF. P. RÂY, M.A.

Presidential Address.

THE DOCTRINE OF VALENCY AND THE STRUCTURE OF CHEMICAL COMPOUNDS.

LADIES AND GENTLEMEN,

While I greatly appreciate the honour of being called upon to conduct the proceedings of the chemistry section of the 19th Indian Science Congress, I am none the less conscious of my own shortcomings and limitations. How much would I have liked that some one more deserving than myself could have been found to hold this position of distinction and responsibility, which has fallen so unexpectedly on me! I, therefore, crave all the more for your goodwill and co-operation, which alone can make this session a success.

Since the goal of chemistry may be defined, in a certain sense, as an interpretation of the structure and properties of molecules, I need offer no apology in selecting 'The Doctrine of Valency and the Structure of Chemical Compounds' as the subject of my discourse. This is a subject of fundamental importance to chemists in general and to the inorganic chemists in special,—a subject which forms the foundation of our science and has seriously engaged the attention of its leading workers since the time of Berzelius. As a result of the marvellous progress within the last two decades in the domain of physics, many of our old cherished ideas about atoms and molecules have undergone profound and revolutionary changes, which demand that the whole of inorganic chemistry should be rewritten before long on a sounder and more rational basis in the light of newer knowledge.

The Atoms.

The ultimate units forming the building stones of our chemical science are atoms. The question, which has naturally troubled the chemists for more than a century, is 'why and how' the atoms combine to form molecules. In spite of various hypotheses and theories, which fill the chemical literature, the subject was as much a mystery a few years back as it was in Dalton's time. Nevertheless, by strenuous endeavours, persistent pursuit and earnest devotion the chemists succeeded in collecting a stupendous mass of facts, and, by

marshalling these, built in reality, as if with an intuitive insight, much better than they knew.

Since the development of the theory regarding the internal structure of the atom by Rutherford and Bohr in 1913, chemists have been in a position to solve this fundamental problem of their science, relating to the nature and the cause of the formation of valence bonds. This modern Rutherford-Bohr model of the atom, as is well known, represents the latter as a very complicated structure with a comparatively small positively charged nucleus, surrounded by a number of electrons moving rapidly in definite, quantized, circular and elliptical orbits,—the number of surrounding or planetary electrons being equal to that of the net positive charge on the nucleus. This number represents the atomic number of the element, whose significance was placed beyond doubt by the brilliant researches of Moseley. The nucleus is responsible for the entire mass of the atom, while the electrons in the outermost level determine its valency, as well as all its chemical and physical properties.

The arrangement of the planetary electrons in different main and sub-quantum groups was first suggested by Bohr[1] on the basis of spectral evidences. It was then modified and developed by Stoner and Main Smith[2] from a consideration of the magnetic properties, X-ray spectra and finer gradations of valency of the elements. Subsequently, based on Hund's[3] theory of spectral terms, the entire scheme of electronic distribution was further revised. These furnished a satisfactory account of the spectral and chemical properties of the elements, including their valency, and, in fact, gave a physical interpretation of the entire Periodic Table.

Chemical Combination.

As soon as the internal structure of the atoms, that accounted for their optical and other physical properties, was revealed, the search after an explanation regarding the cause of chemical combination followed as a matter of course. It is well known to all scientific observers that every spontaneous natural process is attended with a dissipation of energy. In other words, there is a general tendency in nature for the systems to pass from a less stable to a more stable condition. Naturally-occurring chemical changes are no exception to this law. Chemical combinations may, therefore, be said to result from the tendency of the atoms to pass from a less stable to a more stable state. When we examine the elements of the Periodic Table we find that all are not equally prone to chemical combination, some being more reactive than the others; besides, there is a group of elements, known as the zero group, whose members are chemically and electrically

indifferent. These are usually termed 'inert gases'. It may, therefore, be concluded that the atoms of inert gases represent the most stable configurations or equilibrium forms among the known varieties of atoms. All the other atoms will consequently have a natural tendency to assume structures resembling those of the inert gas atoms. This is regarded as the underlying cause of all primary chemical combinations.

Valency and its Mechanism.

Kossel's and Lewis's theories.

The most important ideas regarding the electronic nature of valency were first suggested by W. Kossel[4] and G. N. Lewis[5] in 1916, independently of each other, on the basis of the above supposition. These two famous theories laid the foundation of, and supplied the inspiration for the development of our modern views regarding the constitution of molecules.

According to Kossel, the atoms of elements other than those of rare gases strive to attain the stable electronic configurations of the latter, either by acquiring or losing the necessary number of electrons. Thus, in the series

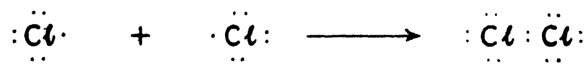
Elements	O	F	Ne	Na	Mg
Electron or atomic number ...	8	9	10	11	12

oxygen and fluorine may assume the stable arrangement of ten neon-electrons by acquisition of two and one electron respectively, which would give them a corresponding negative valency of two and one, leading to the formation of stable $O^{=}$ and F^{-} ions. Sodium and magnesium atoms, on the other hand, may achieve the same stable state by giving up one and two electrons respectively, in order to form Na^{+} and Mg^{++} ions. Thus each unit of valency corresponds with the gain or loss of an electron by the atom. The formation of a molecule like NaF is, therefore, due to the transfer of one electron from the sodium to the fluorine atom, the resulting Na^{+} and F^{-} ions being then held together by electrostatic attraction in the molecule. Sodium fluoride is consequently regarded as a heteropolar compound. Kossel extended this view to the case of remoter elements like nitrogen and carbon in compounds like NH_3, CH_4, CCl_4, etc., though the constituents of these latter seldom appear as ions, due, according to him, to the strong electrostatic attraction of the highly charged central atoms $\overset{--}{N}{}^{-}$ and $C^{==}$ or $\overset{++}{C}{}^{++}$. It was further pointed out that, since the number of planetary electrons in the inert gas atoms is represented as He=2, Ne=2+8, Ar=2+8+8, etc., the formation of a group of eight external electrons is the characteristic feature of all stable arrangements.

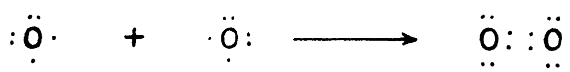
With this simple assumption, based only upon atomic number, he succeeded, without the acceptance of any particular atomic model, in explaining the chemical behaviour of a very large number of inorganic compounds, admittedly of polar character.

Kossel's theory represented undoubtedly a great advance in our ideas of valency, so far as the heteropolar compounds were concerned. But there are molecules like H_2, N_2, O_2, CO_2, SO_2, etc., as well as the vast number of carbon compounds, in which the assumption of such an ionized linkage can hardly be justified by their properties—a fact which Kossel himself did not fail to recognize. They are termed non-polar or homopolar compounds.

A satisfactory explanation of the valence character of this type of compounds was furnished in the same year (1916) by G. N. Lewis, who advanced a very important concept that the attainment of the stable electronic configuration of the nearest inert gas, which underlies the process of all primary chemical combinations, can be effected not only by transfer, but also by sharing of electrons between the atoms in a molecule. Two chlorine atoms, each with a number of seven peripheral electrons, may assume stable configurations of eight external electrons for each by mutual combination to a chlorine molecule, in which a pair of electrons, held in common by the two atoms, serves as the binding link. Each chlorine atom in the molecule contributes one electron to the shared pair. Thus,



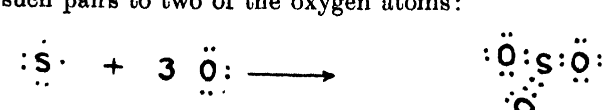
(single bond)



(double bond)

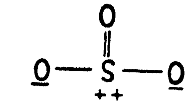
Each unit of valency is thereby identified with a pair of shared electrons. The application of this view to a large number of non-polar compounds was made with conspicuous success by Langmuir[6], who termed this type of linkage as '*Covalency*' and the previously discussed ionized type as '*Electrovalency*'.

In covalency both the shared electrons of a pair may sometimes be supplied only by one of the combining atoms. For instance, the sulphur atom in sulphur trioxide furnishes two such pairs to two of the oxygen atoms:



Each pair, thus shared, would be equivalent under this condition to a double bond, as it increases the valency elec-

trons of oxygen by two and thereby saturates the latter. Such a bond is regarded as a mixed double bond or semipolar double bond by Lowry and Sugden[7], and is represented by means of one polar (electrovalent) and one non-polar (covalent) bond as follows:—



This special type of covalency is also termed co-ordinate covalency or simply co-ordination valency by Sidgwick[8], since it has been found by him to be of special use in explaining the formation of Werner's co-ordination compounds.

Another characteristic feature of Lewis's theory is the assumption of a static atom model—a cubic model, at the eight corners of which are located the eight electrons, corresponding to a stable configuration. The theory is, therefore, usually known as the 'Octet Theory of Valency'.

The above discussed explanation regarding the cause of chemical combination and the formation of valence bonds, however, fails in the case of elements of the transitional groups. The elements in these groups exhibit either variable positive valencies, or, as in the case of the rare earths, a constant or fixed valency. This unusual behaviour in their case is explained by the assumption that, during the evolution of their atoms, some of the vacant levels of inner quantum groups are gradually filled up with electrons at a later stage in the process, after some of the outer groups have been partially possessed. This leads to the building up of quasi-stable structures of pseudo-inert gas type at certain points in the Periodic Table, represented by nickel, palladium and platinum atoms, corresponding with the completion of inner quantum groups.

We thus arrive at two main types of valency, electrovalency and covalency, which satisfactorily explain the formation and constitution of two main classes of chemical compounds—the heteropolar and homopolar. That there are two types of valency, has been recognized by chemists from the long past, as the dualistic theory of Berzelius and the unitary theory of Dumas would suggest.

Physical Interpretation of the Electron-Sharing.

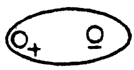
Both Kossel and Lewis built upon static models of atoms, which were found to be untenable. A mechanism regarding the migration and sharing of electrons, based on the dynamic model of Bohr, was, therefore, suggested by Noyes, Knorr, Sidgwick[9] and others, who assumed that in a covalent bond the shared electrons enclose somehow in their orbits the

nuclei of both the combining atoms and stand in some sort of quantum relationship to the latter. On the other hand, ionic or electrovalent linkage leads to the formation of two independent stable electronic systems, held together only by electrostatic forces.

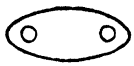
These two types of valency do not, however, represent two entirely independent modes of linkage, but are related to each other as extreme cases of a series of transitional stages, so that one is transformed into the other by imperceptible gradations. These transitional stages are evidently due to a progressive deformation of electronic orbits. As a result of electrostatic action, the electronic orbits of one of the ions may gradually be drawn towards the other till a covalent binding is finally effected. This is illustrated by the following scheme:

Electrovalent linkage.

Transitional stage.



Covalent linkage with a dipole-moment.



Ideal covalent linkage.

Stated in a reversible way, this is identical with Lewis's gradual shifting of the electron pair in favour of one of the combining atoms, till a homopolar bond passes into a heteropolar one. No sharp line of demarcation can, therefore, be set between ionic (electrovalent) and atomic (covalent) bindings. The possibility of such orbital deformation was first indicated by Kossel[4], but has since been realized on the basis of experimental evidences by several investigators, specially by Fajans[10] and his co-workers from a study of molecular refraction.

Covalent linkage, representing a true electronic bond between the combining atoms, has been of great value in accounting for the stereochemical properties of compounds, specially in organic chemistry.

As a result of the latest development of quantum theory on the basis of Schrödinger's wave-mechanical principles, Lewis's conception of homopolar or electron pair bond has been confirmed in a theoretical sense. This links up the idea of valency with the spectroscopic evidence of multiplicity. According to the wave-mechanical conception, the familiar electrons of Bohr's atom have been replaced by 'charged clouds' of varying density representing a time-average of the

positions of electrons, which can, therefore, no longer be given particular location in the atom. Instead of being considered as an assemblage of particles, the atom should now be regarded as a source of waves. Thomson's[11] well known experiment on the interference of cathode rays furnishes striking evidence of the wave-like character of electron streams. In this new theory, all atoms or ions with closed shells are believed to possess a spherical symmetry, which agrees with Kossel's view developed on the basis of general chemical facts. These closed shells are rather static than dynamic, i.e., the density of their charge remains unaltered in time. This aspect of the theory has been emphasized by Sommerfeld[12], and reminds one of the special picture of electron cubes assumed by Lewis.

On the basis of this new theory, London and Heitler[13] first established the principles for the formation of electron-pair bond in the case of hydrogen molecules, and, later on, extended it to more complicated atoms, making use of Pauli's Exclusion Principle[14] and the discovery of 'electron spin'. Pauli's Exclusion Principle states that in any one atom no two electrons can exist completely in the same state. The idea of electron spin signifies that the electron revolves not only around the nucleus of an atom, but can as well rotate about its own axis either in a clockwise or anti-clockwise direction. This, of course, attributes a finite dimension to the electron which was usually regarded as a point charge. The principle enunciated by London may be summarised in the following words.

'If by bringing together two previously separated atom systems, the number of symmetrically bound electron-pairs increases by one, the manifestation and saturation of a homopolar valency are thereby indicated. The spin moments of electrons of the bond-forming pair must be anti-symmetrical or anti-parallel. The valency of an element is smaller than its multiplicity value by one and is equal to the resulting spin moment. The binding force in a homopolar bond arises from the electron interchange between the combining atoms, or from the coupling between their spin vectors.'

Though the substitution of the electron by a charged cloud seems to render many of the familiar electronic conceptions of chemists rather a bit cloudy, and even to frighten many of us with a formidable array of mathematical symbols and expressions, still there is no reason to despair. On the other hand, chemist's conception of homopolar bond has been placed on a definite theoretical basis, and all the results, which follow from Lewis's theory, find their explanation in the new wave-mechanical views. Further, the electronic atom model still retains its former usefulness, since the results of wave-mechanical analysis are always translated back in terms of

this model, which offers a much more convenient mental picture of atoms and molecules.

Metallic Binding.

It might be enquired in this connection as to the nature of the binding force between atoms in the metallic state. An ideal homopolar bond is possible only between two like atoms. In any given metal, the atoms are perfectly alike in all respects. This would suggest the formation of an ideal covalent bond between them, but the electronic structure, thus produced, would depart considerably from the stable configuration of the neighbouring inert gas atom. Besides, the characteristic properties of metals, such as conductivity for heat and electricity, emission of electrons by heat and light, etc., definitely indicate the existence of mobile electrons in them, which renders the assumption of an ideal homopolar linkage absolutely untenable in their case. The electropositive metallic atoms have a strong tendency to part with their valence electrons. Hence in the metallic state, the valence electrons of neighbouring atoms tend to leave their individual owners; but as none of them would tolerate any excess of electrons in their own sphere, these valence electrons would simply vibrate between the atomic cores. Such a view is more or less supported by the theory of metallic state, as elaborated by Sommerfeld[15], on the basis of quantum theory in its newly developed wave-mechanical phase. According to Sommerfeld, in a close packing of metallic atoms in their lattice, the external electrons are freed from their mother atoms and behave like an electron gas enclosed in an electrostatic cage of positive metal ions, being in constant and irregular motion inside it. A metallic bond can, therefore, be represented by the symbol,

Classification of Chemical Compounds.

Having discussed the nature of various types of valence bonds, we shall now deal with the physical and chemical evidences that lead to their recognition. The chemical compounds may conveniently be classified for this purpose under two main heads and discussed separately.

I. Compounds of the first order, which may again be subdivided into:—

(*a*) Salt-like or heteropolar compounds;
(*b*) Homopolar compounds including the carbon compounds;
(*c*) Metals and metallic compounds.

II. Compounds of the second and higher order, further sub-divided into:—

(*a*) Simple molecular compounds.
(*b*) Complex molecular compounds.

I. Compounds of the First Order.

Conductivity.—The most obvious evidence for an ionic bond or otherwise is the direct observation of ionization in aqueous solution by means of conductivity measurement. The method can also be applied to molten substances, as has been done by Biltz and Klemm[16] in the case of a number of metallic and non-metallic chlorides.

Crystal Structure.—Evidence of ionization in the solid crystalline state has been obtained for substances like sodium chloride from a study of the Residual Ray (Rest-strahlen) phenomenon. The high reflecting power of these crystals indicates their conducting character and the presence of charged constituents.

A close relationship between the crystal structure and the nature of the linkage between two atoms in the molecule of a binary compound has been established by Grimm and Sommerfeld[17]. The following main types of compounds are characterised by definite physical properties and crystal lattices, associated with a definite nature of the valence bond.

Salts.—These are solid, mostly soluble and difficultly volatile substances which crystallize in ionic lattices. There are no molecules in the kinetic sense to be found in the lattice, the points in the latter being occupied by positive and negative ions. The lattice energy in the crystal is derived from the residual unbalanced force on each of the combining ions, and is, therefore, of an electrostatic character. This accounts for the non-volatility of salt-like compounds, as well as for their electrolytic conductivity in fused condition. Substances, crystallizing in rock salt or cæsium chloride type, form ionic lattices, and hence consist of molecules with ionic or heteropolar bond. In the case of ternary compounds, fluorit type of crystal structure represents an ionic lattice.

Indirect evidence, regarding the ionized nature of the valence bond in salt-like compounds, has also been adduced by Grimm and Herzfeld[18] from a calculation of the heat of formation of a number of existing and hypothetical binary compounds by means of Born's cyclic process.

Non-metallic molecules.—These are usually volatile, and form very soft crystals. Molecules like H_2, N_2, O_2, NO, H_2O, etc., as well as all organic compounds belong to this class. In the condensed and crystalline state they are held together by two types of binding forces, the strong inner-molecular covalent binding and a very weak inter-molecular ill-defined

attraction. On crystallization they form molecular lattices, in which the lattice energy is very feeble. The volatile nature and low hardness of their crystals are thus easily accounted for.

Substances of the diamond type.—These, represented by diamond, silicon carbide, aluminium nitride and zinc sulphide, are solid, difficultly volatile, almost insoluble and extremely hard substances. Their crystals form atomic lattice and belong to the diamond or Wurtzite (zinc sulphide) type, in which the atoms are linked together in a tetrahedral arrangement, being held by strong forces similar to the inner-molecular forces in non-metallic molecules. The entire crystal forms, as it were, a giant molecule in which all the atoms are linked with each other by atomic or homopolar bonds. A characteristic feature of this type of compounds is that the sum of the valence electrons of the two constituent atoms always equals eight.

Metals, metallic compounds and alloys.—These are solid, difficultly volatile substances with characteristic metallic properties As already stated, they crystallize in the metallic lattice. Hence the formation of metallic molecules and compounds is seldom controlled by usual valence regulations, based on the number of valence electrons.

Rare gases.—In gaseous condition they are monatomic. When crystallized they form atomic lattice; the binding force between the atoms is extremely weak and is identical with inter-molecular or Vander Waal's forces.

Goldschmidt[19] has also shown that the nature of the binding forces between the building stones of a crystal is essentially connected with the following experimentally determined data.

1. The type of geometrical arrangement of the atoms in a crystal.
2. The distance between the atomic centres in a crystal.
3. Hardness.
4. Electrical and electro-optical properties of the crystal.

He formulates two important types of crystal lattices, co-ordination lattice and molecular lattice. The former includes ionic lattice, metallic lattice, and atomic lattice of the diamond-zinc blende type. Compounds like CO_2, NH_3, SO_2, NO, etc., in the solid state, as well as all organic compounds form, as stated above, molecular lattices. A transition between atomic lattice and molecular lattice is shown by what is known as the layer lattice (Schichtengitter) in compounds of the type CdI_2 and $Mg(OH)_2$.

The distance between atomic centres in a crystal gives an idea about the strength and nature of the binding force.

Hardness of a crystal, which is a direct measure of the lattice energy, has been found to vary with atomic distances and valency, decreasing with the former and increasing with the latter in co-ordination lattices.

Finally, electric and electro-optical properties of crystals, pyro- and piezo-electrical properties, as functions of charged particles, furnish numerous data of considerable importance for recognition of the variety of valence bonds.

Molecular Refraction and Ionic Deformation.

It has already been pointed out that, between the two extreme types of ideal ionic and ideal atomic bond, there is a number of transitional stages due to the deformation of electronic orbits of the ion, under the influence of the field of its neighbours. Fajans[10] has shown that a very convenient and reliable means to determine the nature and extent of this deformation lies in the study of molecular refraction which, in an ideal heteropolar compound, behaves as an additive property, being made up of the characteristic ionic refractions of the constituents. Any deviation from the additive value indicates deformation or polarisation. Through a series of brilliant researches Fajans and his co-workers have been able to prove that the molecular refraction of an anion decreases, and that of a cation increases, with increasing deformation. Anions are evidently more deformable than cations, as in the former, due to its negative charge, the electrons are more loosely bound.

Fajans summarizes the conditions most favourable for deformation in the following words:—

The smaller is the volume and higher is the charge of a cation, greater is its deforming action upon the anion. On the other hand, the larger is the volume and higher is the charge of an anion, the more is it deformed. The deforming action of a cation (such as Fe^{III}, Co^{II}, Ni^{II}, etc.) without an external shell of the inert gas type is greater than that of the one with an inert gas shell.

The nature of the chemical bond in a molecule, therefore, will depart more and more from the ideal ionic type, approaching that of the non-ionic one, as the deforming action of the cation and the deformability or polarisability of the anion increases.

The deformation of electronic orbits often manifests itself in the development of colour, as the deformed orbits, being loosely held, belong to a higher quantum level.

Parachor and the Chemical Bond.

The work of Sugden[20] on molecular volume at constant surface tension, which is independent of temperature and has

been termed 'Parachor' by him, supplies important informations regarding the nature of the valence bond. Sugden has shown that the molecular parachor, $P = \frac{M \cdot \gamma^{\frac{1}{4}}}{D-d}$ (where M = mol. wt; γ, D and d are the surface tension, density of the liquid and its vapour respectively at any given temperature), is an additive property and is equal to the sum of its atomic parachors, together with necessary corrections for certain structural constants. Each type of atom has got its own constant parachor value. The parachor value for a single non-ionic bond is arbitrarily chosen as zero, and hence serves as the reference level. A triple bond, double bond, rings with different numbers of atoms, etc., have their own characteristic values. The parachor constant for a polar or ionic bond, which is identical with that for a co-ordination or semipolar double bond, is negative and small. This provides a strong support for the distinction that has been made, on the basis of the electronic theory of valency, between a normal covalent bond, a co-ordination covalent or semipolar double bond, and a true double bond. The parachor contributions for these structural terms are 0, $-1{\cdot}6$ and 23.2 respectively. A true double bond evidently indicates a sharing of four electrons.

The parachor values have been determined for about 267 substances, and all these show a satisfactory agreement with the calculated values, inspiring a great confidence in the theory.

The parachor determination in certain cases indicates, however, the formation of a single-electron bond, to which a value of $-12{\cdot}4$ is attributed by Sugden.

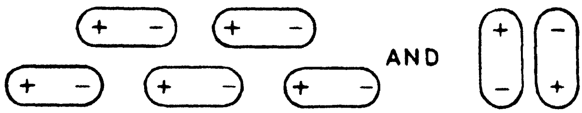
Dipolemoments.

From a study of the dipolemoments of molecules, whose theory was first developed by Debye[21], information about the extent of electrical disturbance inside a molecule can be obtained. A molecule of sodium chloride, for instance, represents an ideal electrical dipole, consisting of two opposite unit charges separated by a definite distance. The effect of such a dipole is measured by its electrical moment. Hence, ideal covalent molecules possess no dipolemoment. Development of a permanent dipole character, shown by a large number of substances, evidently results from the distortion of electronic orbits or shifting of the shared electron pairs in the molecule. The strength of the dipolemoment, therefore, serves as a measure of transition between homopolar and heteropolar bindings. Polarities of this latter type, consequent on the shifting of shared electron pair in the molecule, have been largely assumed in developing the electronic theo-

ries in organic chemistry, generally known as the 'theory of alternate induced polarity'.[22]

The term dipole molecule is mostly applied to those with such partial polarities, as distinct from ionized molecules of the sodium chloride type, and is represented by the symbol,

The capacity for molecular association, exhibited by many substances, is closely connected with their dipolemoment as shown below, and should therefore be regarded as derived from pure electrostatic attraction.



Sidgwick's[23] interpretation of the same, as a result of actual chemical combination due to electron sharing, has, however, not much convincing evidence in its favour. We shall further learn that the dipole theory plays an important part in the formation of molecular complexes.

Absorption Spectra and Valency.

The relation between absorption spectra and the nature of the chemical bond has been studied with respect to:

(i) X-ray absorption.
(ii) Absorption in visible and ultraviolet region.
(iii) Infra-red absorption and the Raman Effect.

(i) X-ray absorption.

Lindh[24] and Stelling[25] have shown that the frequency of the K-absorption edge of any given element in a compound or radicle varies primarily with its valency, and increases with the latter for positive ions. This is evidently due to the fact that the wave-length of the absorption band is determined by the energy required to remove a K-electron from its normal level to a position outside the atom. This energy naturally increases with the positive charge of the atom. The position of the absorption band is also influenced by the nature of the chemical bond. The absorption frequencies of chlorine and sulphur in various chlorides and sulphides depend on the nature of the positive atom, i.e., on its deforming or polarising power. With increasing deformation of the anion, its absorption edge is gradually shifted towards shorter wave-length; or in other words, with increased positive character, the bond becomes harder as explained above. Introduction

of neutral molecules like H_2O and NH_3 between the positive and negative ions lowers the anionic deformation on account of the increased distance, and consequently the absorption edge of the latter becomes softer or displaced towards the red. The study of the K-absorption spectra, therefore, serves to distinguish, and indicate the transition, between homopolar and heteropolar bindings.

Much interesting results have been obtained in the case of certain complex cobalt and chromium salts containing chlorine. When compared with those for gaseous chlorine and other metallic chlorides, the results furnish strong evidences in support of Werner's view of the constitution of complex compounds. This is evident from the values tabulated below[25].

Substance.	Wave-length in X.U. for chlorine.	
	K_1	K_2
$[Co(NH_3)_6]Cl_3$	....	4385·6
$[Co(NH_3)_5Cl]Cl_2$	4391·8	4384·6
$[Co(NH_3)_4Cl_2]Cl$	4392·3	4384·0
$[Co(NH_3)_5Cl](NO_3)_2$	4391·7	4384·0
$[Co(NH_3)_4Cl_2]NO_3$	4391·8	4382·6
$[Co(NH_3)_4(NO_2)_2]Cl$	....	4384·8
$[Cr(NH_3)_6]Cl_3$	....	4386·3
$[Cr(H_2O)_6]Cl_3$	....	4384·4
$[Cr(H_2O)_4Cl_2]Cl$	4391·5	4384·0
$[Cr(NH_3)_3Cl_3]$	4390·7	4382·9
$CrCl_3$(sublimed)	4391·4	4380·2
$NiCl_2$(sublimed)	4390·7	4383·8
$CuCl_2$(anhydrous)	4391·7	4384·2
CuCl	....	4384·1
LiCl	....	4383·8
$LiCl . 2H_2O$	.....	4385·4
NaCl	....	4383·9
$CaCl_2$	....	4384·4
$CaCl_2 . 6H_2O$	....	4386·4
Cl_2	4393·8	4381·6

Compounds containing chlorine atom, only outside the co-ordination zone, gives merely one absorption edge corresponding to that of chlorine ion in simple salts of the NaCl type. Those containing chlorine inside the complex show, however, two edges agreeing closely with those of gaseous chlorine in wave-lengths. This proves that the chlorine atom inside the complex is held by a covalent or co-ordination bond. In anhydrous chlorides of chromium, nickel and cupric copper, the valence bond, as the results indicate, is of a non-polar type, due evidently to a strong deformation of the electronic orbits of chlorine.

(*ii*) *Absorption in visible and ultra-violet region.*

From a consideration of the character of absorption spectra of diatomic molecules, either as a gas or in a state of vapour, Franck[26] has determined the nature of molecular dissociation induced by the absorption of light He has shown that non-ionic or atom-molecules dissociate by light energy into a normal and an excited atom. Within atom-molecules he includes the elementary molecules with an ideal covalent bond, like H_2, N_2, O_2, Cl_2, etc., as well as molecules with small dipolemoment, namely, NO, CO and ICl, since under normal conditions it is the atoms which oscillate inside these molecules. Compounds, such as AgI, AgBr, AgCl and HCl, have been found to behave spectroscopically as atom-molecules.

In the case of ionic molecules, in which the ions vibrate against each other under normal conditions, dissociation by light results primarily in the production of two normal atoms, though ultimately it may lead to a normal and an excited atom. These two characteristic ways of molecular dissociation by light may, under certain reservations, serve as a criterion for distinction between ionic and non-ionic linkages

Dutta and Saha[27] have, however, observed that the vapours of the tetrachlorides of carbon, silicon, titanium and tin give a continuous absorption and behave like sodium chloride, which should, therefore, in the light of Franck's work, be regarded as ionic compounds. But all physicochemical evidences definitely indicate the contrary. This raises the question of validity of Franck's conclusion.

Absorption spectra of substances in solution and in the solid state have also been largely investigated with a view to interpret the nature of the chemical bond inside a molecule. From a careful examination of the absorption spectra of ester, salts and free acids, Hantzsch[28] has shown that the spectra of an ester differs greatly from that of the salt, whereas the free acid gives a spectrum which resembles that of the ester and often possesses an intermediate character between the two. If the bond is ionic in salts, which it evidently is, that of the ester should bé regarded as non-ionic.

In compounds like iodides of zinc, cadmium and mercury, whose absorption spectra in ethyl alcoholic solution consist of two bands, it has been observed that the latter are gradually shifted towards the red in the order, Zn—Cd—Hg. This suggests that with the increased polarizing capacity of the cation, the binding becomes increasingly non-polar in strong solutions; for, by diluting the alcoholic solutions of zinc and cadmium iodide to a mol. volume of 50,000 litres, the molecular spectra have been found to disappear, giving rise to that of the iodine ion[29].

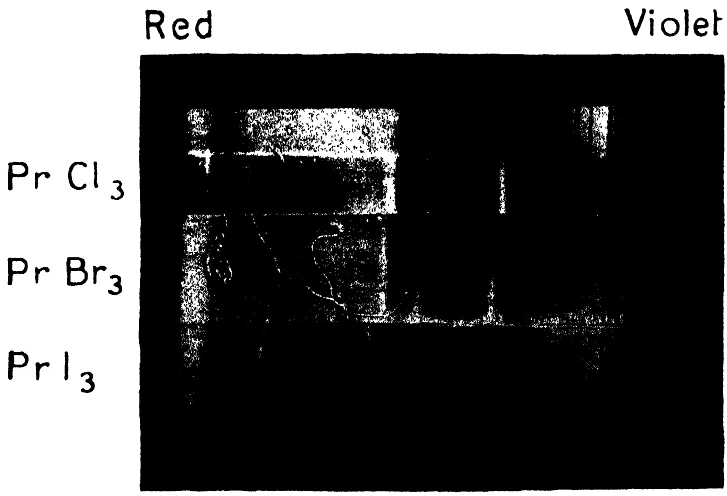
Similar observations have also been made on a more definite scale in the case of the absorption or rather reflexion spectra of solid compounds, specially the rare earth salts. The absorption spectra of these latter are characterised by sharp and well-defined narrow bands, which are, therefore, naturally attributed to the excitation of mobile electrons of the inner 4_4-quantum level of the earth atoms. The reflexion spectra of praseodymium compounds have been found to vary with the nature of the anion. In the halides, for example, the praseodymium spectrum is gradually shifted towards the red with increasing atomic weight of the halogen, and consequently with its increased deformation. In the case of hydrated and ammoniated halides, on the other hand, the bands are displaced towards the violet end[30]. This behaviour has been explained by Ephraim and Rây[31] in a manner parallel to that suggested for the displacement of X-ray absorption bands.

The anhydrous praseodymium halides may be regarded to depart considerably from the character of an ideal electrovalent compound. Nevertheless, a sort of polarity inside the halide molecules develops itself, as the electronegative halogen atom makes a greater demand upon the possession of the shared electron pair, which is thereby shifted towards the latter. The magnitude of this shift increases naturally with increased electron-affinity of the halogen atom. Consequently, the praseodymium atom becomes increasingly more positive in its halides in the order, iodide—bromide—chloride—fluoride. This makes the energy required for the excitation of an electron from the 4_4-layer of the praseodymium atom, which is responsible for its absorption spectrum, increase exactly in the same order. This accounts for the gradual displacement of spectral bands observed in its halides. In the hydrates and ammoniates, the dipole molecules of water and ammonia, by their attachment to the central metal atom, weaken the latter's hold upon the shared electron pair, thereby helping the dissociation of the halide molecules into ions. The violet shifting of the absorption bands of hydrates and ammoniates is thus easily explained. The reflexion spectra of neodymium and samarium compounds[32] show analogous relationship among themselves, in spite of certain complications due to the large number of bands.

The following table gives measurements for the spectra of praseodymium halides[30].

	I.	II.	III.
PrI_3	456·5	482·1	495·9mμ
$PrI_3 \cdot 6H_2O$	448·4	473·7	485·5mμ
$PrI_3 \cdot 9H_2O$	445·2	470·8	484·5mμ
$PrI_3 \cdot \infty H_2O$	443·9	468·9	482·0mμ
$PrBr_3$	453·2	478·8	493·0mμ
$PrBr_3 \cdot 6H_2O$	446·2	471·8	484·5mμ
$PrBr_3 \cdot \infty H_2O$	444·1	469·0	482·3mμ
$PrBr_3 \cdot 9NH_3$	449·8	475·0	488·5mμ
$PrCl_3$	450·3	475·5	489·8mμ
$PrCl_3 \cdot 7H_2O$	446·2	472·7	482·8mμ
$PrCl_3 \cdot \infty H_2O$	444·7	469·0	482·4mμ
$PrCl_3 \cdot 8NH_3$	449·1	474·4	488·0mμ
PrF_3	442·5	468·0	480·3mμ

A clear view of the gradual displacement of the absorption bands of praseodymium halides is obtained from the following print.



Even in solutions, chlorides, nitrates, perchlorates, etc. of Pr, Nd, Sm and some other rare earth elements have been found by Selwood[33] to give a slight shift of their absorption bands towards the red with increasing concentration. It was observed further that this behaviour was

connected with the diminution of magnetic susceptibility and the increase of molecular refraction with concentration of the solution. All these effects are evidently related to a gradual transition from an ionic to a non-ionic binding with the rise in concentration of the salt solution.

(*iii*) *Infra-red absorption and the Raman-Effect.*

A large volume of work has been done on the infra-red absorption spectra with a view to elucidate the shape, size and structure of molecules. Each valence bond in a molecule is characterised by a fundamental vibration frequency of the atomic cores, which appears as an absorption band in the infra-red region. From the number of such bands, the shape and structure of the molecule are deduced. A notable achievement in this field consists in the detection of isotopes from a study of the infra-red bands. But, due to the difficulties of technique involved in the method, the progress made so far has not been, from a chemist's point of view, commensurable with the labour devoted upon it.

Fortunately however, in the recent discovery of Raman Effect by Sir C. V. Raman, a powerful, precise, extraordinarily simple and unique means has been found to explore the nature and strength of the chemical linkage, as well as the shape and structure of molecules. Streams of papers dealing with the subject are continuously pouring in not only from Sir C. V. Raman's own laboratory, but also from all other active research centres of the world, and within a very short time a remarkable advancement in our idea of molecular structure has been achieved by its aid.

The Raman Effect[14] is produced as lines of modified wave-lengths, associated with that of the incident radiation, in the spectrum of the light scattered by a substance, and may be represented by a reversible energy-reaction between the light quanta and the molecule of the substance according to the scheme,

M	+	$h\nu$	$\rightleftarrows$	M*	+	$h\nu'$.
(normal molecule)		(energy of incident radiation)		(excited molecule)		(energy of altered radiation)

The essential features of this new radiation from a chemical point of view are: its universality, being observed in gases, liquids, vapours, crystals and glasses; and its representation as an exchange of energy between the light quantum and the molecule. The frequency difference is completely independent of the wave-length of the exciting radiation, and coincides in magnitude with the infra-red absorption frequency for the molecule. Certain inactive frequencies, not occurring in the infra-red absorption,

appear, however, most prominently in the Raman spectrum. A valence bond between any two given atoms in a molecule has its characteristic frequency shift $\Delta(\nu)$, which, under usual circumstances, is only slightly influenced by neighbouring atoms, different states of aggregation and temperature. The strength of the valence bond is calculated from the magnitude of the shift.

A study of the Raman spectrum combined with the infrared absorption gives the number and frequency of all the fundamental vibrations of the molecule, from which, with the help of certain assumptions, conclusions about the space-configuration of the molecule can be made. Thus, calomel, in agreement with many of its other physico-chemical properties, has been proved to possess a rod-shaped structure and a bimolecular composition, $Cl-Hg-Hg-Cl$. Sulphate ion gives a tetrahedral, and a carbonate or nitrate ion a pyramidal model respectively[35].

Krishnamurti has shown that the Raman spectrum serves as a distinguishing test for covalent and electrovalent bonds Molecules with electrovalency give no Raman lines, whereas they come out prominently from covalent molecules. A large number of metallic and non-metallic chlorides, examined by Daure[36] and Krishnamurti, has been arranged by the latter under three classes[35]:

(i) Those giving strong Raman lines, viz., chlorides of Hg^{I}, Hg^{II}, P, As, Sb, C, Si, Ti, Sn and H;

(ii) Those giving faint Raman lines, namely, $BiCl_3$, $ZnCl_2$, CdI_2 and $AuCl_3$;

(iii) Those giving no Raman lines, e.g., chlorides of Na, K, NH_4, Ba, Ag, Cu^{II}, Cd, Mg, Sn^{II}, Th, as well as $CdBr_2$, PbI_2, KI, LiF, NaF and CaF_2 Curiously enough PCl_5 gives Raman lines none of which coincide with those of PCl_3.

This differentiation of the halides, on the basis of their Raman spectra, is in close agreement with the results of their conductivity measurements in the fused state[16]. That the excitation of Raman lines is only possible in a covalent compound, is hereby definitely established. The occurrence of faint lines, other conditions remaining unaltered, indicates a transitional stage between ionic and non-ionic bonds. The influence of association and of neighbouring atoms upon the frequency shift of any given bond can be explained on the basis of alteration in the strength of the covalent binding, resulting from orbital deformation. Thus, the frequency of NO_3^- ion has been found to decrease with increasing water-content of the crystals, as shown below[37].

$LiNO_3$		$Ca(NO_3)_2$		$Sr(NO_3)_2$	
Anhydrous	1086	Anhydrous	1064	Anhydrous	1054cm^{-1}
$\frac{1}{2}H_2O$	1073	$4H_2O$	1045	$4H_2O$	1054 „
$3H_2O$	1050			$6H_2O$	1053 „
				$9H_2O$	1044 „

In the case of anhydrous nitrates, the influence of the cation shows itself in the decrease of NO_3 frequency with increased deforming action of the metallic ion. Similar observations have also been made by Pal and Sengupta[38] on certain simple and complex metallic cyanides with reference to CN frequency.

From a study of the Raman spectra of various nitrates, sulphates, cyanides, thiocyanates, etc., Krishnamurti concludes[35] that the influence of surrounding atoms and the nature of binding upon the frequency of vibration can be expressed in the following words:—

(i) The frequency of any given bond in a radicle rises in covalent compounds, of which the radicle forms a part, and approaches the normal value in compounds of electrovalent character.

(ii) Increase of charge on the cation increases the frequency, increase of size however reduces.

It is rather difficult to explain all cases on these assumptions, and more experimental data will be needed before any such generalization becomes possible.

Raman spectra have also been found useful in determining the nature and degree of electrolytic dissociation. It thus serves as a test to detect the presence of non-ionized covalent molecules in solution.

Magnetic Susceptibility.

Valuable informations about the nature of valency are also derived from the magnetic properties of chemical compounds. Substances can be arranged in three different classes according to their behaviour in a magnetic field, namely, diamagnetic, paramagnetic and ferromagnetic. Diamagnetic substances have no magnetic moment of their own; the paramagnetic substances have got a weak, and the ferromagnetic a very strong magnetic moment. Hence, in a non-homogeneous magnetic field, the diamagnetic bodies are repelled out of the field, while the paramagnetic substances are weakly, and

the ferromagnetic ones are strongly attracted towards the field.

The dia- and paramagnetic properties of substances have been explained on the basis of modern atomic structure. Every individual electron in an atom possesses a magnetic moment of its own, contributed both by its orbital motion and axial rotation or spin. When the moments of different electrons mutually neutralize in full, as is the case in a completed electronic group or sub-group, the atom becomes diamagnetic. In the case of imperfect neutralization paramagnetic properties develop. The quantitative values of magnetic properties are usually expressed in susceptibility per gram or gram molecule of the substance. For paramagnetic bodies, units of magnetic moment in the form of Weiss's or Bohr's magneton are also freely used. The magnetic moments of the ions of the rare earth elements have been explained by Hund[40] from spectroscopic considerations, and those of the ions of the elements of the first transitional group by Bose and Stoner[41]. As is well known, all these elements are characterised by having incomplete groups of electrons in their atoms. According to the wave-mechanical views, the orbital and spin moments of the electrons, participating in the formation of a covalent bond, are completely balanced or neutralized[42]. The magnetic moment of a paramagnetic atom is, therefore, reduced by the formation of a covalent linkage. The variation of valency in a paramagnetic ion also produces a profound alteration in its susceptibility, due to a change in the number of electrons in the incomplete shell. A comparison of the moments of Fe^{II} and Fe^{III} as well as of Cu^{I} and Cu^{II} ions makes it clear.

The nature of the valence bond and the structure of the molecule can, in many cases, be conveniently determined by measuring the magnetic moments of the substances under investigation. Mercury atom, for instance, with two electrons in the completed valence shell, naturally gives diamagnetic Hg^{II} ion or mercuric (covalent) compounds. Hg^{I} ion or covalent mercurous compound should, on the other hand, be paramagnetic. But, as a matter of fact, all mercurous compounds are diamagnetic. This can be explained only on the assumption that the mercurous salts are bimolecular, and contain the group Hg – Hg, either as Hg_2^{++} ion or as X – Hg – Hg – X. This has been actually verified by the X-ray analysis of calomel[43]. The study of Raman spectra and many other physico-chemical properties furnish evidences to the same end.

The magnetic moments of the rare earth sulphides of the formula MeS_2 have been found to be identical with those of their compounds of the type MeX_3. Hence, it is concluded that the earth atom in MeS_2 is not tetravalent but trivalent,

and the sulphides are true polysulphides of the formula $Me_2S_3.S$[43].

Bose[44] has found that hydrated nickel cyanide, $Ni(CN)_2.6H_2O$, has the same magnetic moment as all other simple nickel salts, whereas the anhydrous cyanide is diamagnetic. This definitely indicates a transformation from an electrovalent into a covalent bond on dehydration. In a covalent nickel salt, the 3_3-shell is completed by gaining two electrons for two covalent bonds, while in Ni^{++} ion it remains incomplete, having only eight electrons.

Transitional stages between electrovalent and metallic bindings can also be detected by means of magnetic measurements. The magnetic moment of CuS is practically nil, whereas that of Cu^{++} ion in its salts amounts to about 9 Weiss magneton number. CuO, on the other hand, shows an intermediate value between the two. This anomalous behaviour is best accounted for, as Klemm[43] has shown, by the supposition that a transition towards metallic state occurs in these cases and is practically complete in CuS.

The magnetic moments of complex ions and molecules have been found in many cases to differ widely from those of simple ones. The relationship between the nature of binding in complex molecules and their magnetic properties will be discussed in a subsequent section.

The magnetic properties of diamagnetic substances are more or less of an additive character. Pascal[45], who has examined a large number of organic compounds, has shown that their diamagnetic molar susceptibilities can be expressed as the sum of the atomic susceptibilities, with certain corrective terms depending on the character of the covalent bond.

Some Physico-Chemical Evidences.

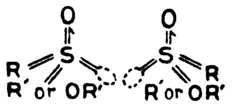
Solubility.—The solubility of a substance often supplies useful informations regarding the nature of valence bonds. A true solution indicates complete miscibility of the solute and the solvent molecules so that all phase distinctions are removed, possibility for which increases with the similarity of the two types of molecules. This similarity, where it does not already exist, may be brought about by the process of solvation or hydration. Salts with ionized bonds are usually soluble in water and liquid ammonia, whose dipole molecules are readily attached by the salt ions. On the other hand, they are insoluble in many organic solvents of non-polar character, since these offer little possibility for solvation. Compounds with covalent binding are easily soluble in organic solvents on account of the close resemblance between the solvent and the solute molecules, both being characterised by the same type of linkage.

Stereo-chemical considerations.

We have seen that the parachor determination furnishes strong evidence in favour of semipolar double bond. This is further confirmed by stereo-chemical considerations of certain sulphur compounds. Derivatives of sulphinic acid and sulphoxides may be represented by the general formula

$$\left.\begin{matrix} R \\ R' \text{ or } OR' \end{matrix}\right> S=O \, .$$

Assuming that the sulphur atom has a tetrahedral structure, the oxygen atom may either be linked by a convential non-polar double bond, occupying two corners of the tetrahedron, or by a semipolar double bond at one of the corners. The molecule, in the latter case, can exist in two enantimorphous forms, as shown by the following electronic formulæ:



This has been actually verified by the resolution of a number of such sulphur compounds by Phillips and his co-workers[46]. Oxidation of sulphinic esters to sulphonates and of sulphoxides to sulphones immediately destroys the activity, as a plane of symmetry is thereby developed in the molecule. The presence of semipolar linkage in sulphonates and sulphites is also indicated by their parachor determination[47].

Some unexplained cases.

There are certain compounds of the first order, whose constitutions, on the basis of the electronic theory, are not yet quite clear and are interpreted in a different manner by different authors. They are: SF_6, PF_5, PCl_5, IF_5, ICl_3, BrF_3, B_2H_6, KI_3, etc. Of these, SF_6 is an extraordinarily stable compound; PF_5 and IF_5 are also quite stable. The binding in these higher halides of S, P and I is evidently covalent, the substances being either gaseous or extremely volatile. The assumption of normal covalent bonds in their molecule, however, violates the octet rule. Hence Sugden, following Prideaux[48], holds that they should be represented as having two or more singlet linkages or one-electron bond in their molecule. The parachor value of PCl_5, determined by Sugden, seems to support this view remarkably well. This is rather a chance coincidence, and unless the parachor values of other higher halides, mentioned above, be determined and found to agree with this representation, it would be difficult to accept this conception of singlet linkage for the sake of maintaining the octet rule. One-electron bond should certainly

lend instability to a molecule, and there is no reason to assume that highly stable compounds like SF_6 and PF_5 contain such linkages. Of late, however, Sidgwick[49] and his co-worker have determined the parachor value for a compound of tervalent iodine, iodosobenzene propionate. It showed a parachor defect of 17·3 units instead of about 26, as might be expected, on the analogy of phosphorus and antimony pentahalides, according to Sugden's representation. The assumption of singlet linkage, therefore, fails here. Evidently these parachor anomalies, exhibited by some elements in their higher valencies, should be attributed to an enlarged electronic shell beyond the normal octet, as has already been pointed out by Sidgwick[50]. The dielectric properties of $SbCl_5$ and PCl_5, showing that they possess practically zero dipole moment, are in support of this view[51].

The valency of the above described higher halides is, however, best explained on the basis of the newer quantum mechanics, as suggested by London[52]. The electronic disposition of the phosphorous atom may be represented as follows:—

Quantum number l ..	0	1	2	Valency.	State of the atom.
Quantum number m_l ..	0	−1 0 1	−2 −1 0 1 2		
Electrons ..	2	1^+ 1^+ 1^+		3	Normal.
" ..	1^+	1^+ 1^+ 1^+	1^+	5	Excited.

Only the electrons of the valence shell are shown, and the main quantum number is omitted.

l = serial quantum number,
m_l = magnetic quantum number,
+ indicates positive spin.

For the same m_l value, an electron may have two spin quantum (m_s) values of positive and negative character. Now, according to the wave-mechanical representation, a covalent bond results from the coupling of opposite spin moments of a duplet of electrons. Hence an excited phosphorus atom may have a higher valency of five, giving rise to a more or less stable shell of ten electrons. In the non-excited atom, the spin moments of the two electrons in the l_0-level balance mutually or are coupled together. They are, therefore, not available as valence electrons. In the nitrogen atom, where the value of the main quantum group, 2, limits the l value to 1, the excited atom, unlike phosphorous, cannot give five covalent bonds, but may have four covalent and one

electrovalent bond by losing one electron. This gives rise to NH_4^+ ion, as is shown in the following scheme:

Quantum number l .. / m_l ..	0 / 0	1 / −1 0 1	Covalency.	State of the atom (N).
Electrons ..	2	1^+ 1^+ 1^+	3	Normal.
,, ..	1^+	1^+ 1^+ 1^+	4	Excited.

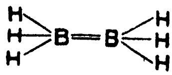
Hexa-covalency of sulphur with a stable shell of twelve electrons can be similarly represented. The higher halides of iodine and bromine also present no difficulties when viewed in this light. The formation of such stable shells of ten and twelve electrons was first suggested by Lewis.[53] How far the assumption of singlet linkage is permissible on the basis of wave-mechanics is not yet quite clear, though Sugden has put forward a plausible quantum scheme for PCl_5 with one-electron bonds.[54]

The case of boron hydride, B_2H_6, represents a very vexed problem of valency. Notwithstanding the several views suggested, its constitution remains as much undecided as heretofore.[55] Sidgwick[56] admits the existence of singlet linkage in the hydrides of boron. But the most plausible suggestion is due to Eastmann, Hellriegel and specially to Müller[57]. According to this, the two inner electrons of the boron nucleus are supposed to act as valence electrons, and take part in the completion of its octet. Based on London's view, this can be represented as follows:—

Main quantum number.	1	2		Covalency.	State of the boron atom.
Subsidiary quantum number l .. / m_l ..	0 / 0	0 / 0	1 / −1 0 1		
Electrons ..	2	2	1^+	1	Normal.
,, ..	2	1^+	1^+ 1^+	3	Excited.
,, ..	2	..	1^+ 1^+ 1^+	,,	,,
,, ..	1^+	1^+	1^+ 1^+ 1^+	5	,,

In B_2H_6, the boron atom may be regarded as existing in the last excited state and to exert an apparent covalency of five. Both the boron atoms thereby complete their outer octets and assume the neon configuration with ten electrons in each, arranged in corresponding quantum levels. The electrons in I_1- and 2_1-quantum levels are shared between the boron atoms themselves, those of the 2_2 with hydrogen atoms. Depicted in the electronic and the usual notations of valency, it gives the following pictures.

(Electronic.)



(Usual.)

The two bent lines indicate a duplet bond in 1_1-level, and the two straight lines between the boron atoms, a duplet in the 2_1-level. This would evidently generate a great strain inside the molecule, accounting for its instability. Its physical resemblance to ethane is also set forth by the above formula, which is practically identical with the one proposed by Müller.

It should, however, be pointed out that in an element of low atomic number like boron, the excitation of an electron from the first main quantum level to the second by means of chemical energy is not at all unlikely, as it has been found, by calculation on the basis of Duane and Hunt's equation, that the k_α-frequency for boron lies at or about the extreme ultra-violet region near the boundary zone.[58]

Compounds of the type KI_3 and KBr_3, as is well known, contain the complex ions like I^-_3 and Br^-_3. These latter are extremely unstable and are evidently formed by electrostatic attraction between the free ions (I^-, Br^-,) and neutral molecules (I_2, Br_2). Such combinations may be regarded as a case of induced valency. The formation of higher polyhalides, MX_5, MX_7, MX_9, etc., is in perfect agreement with this idea.

II. Compounds of the Higher Order.

Having dealt with the valence condition and structure of compounds of the first order, we shall now proceed to discuss those of the higher order. These are formed by the union of two or more different simple molecules, themselves with saturated valency, and, as stated before, may be classified under two main groups:

(i) Simple Molecular Compounds

and

(ii) Complex Molecular Compounds.

The latter can again be subdivided into (*a*) imperfect and (*b*) perfect complexes, depending on their chemical and

physical properties. The distinction between the different classes is, however, never sharp, and one often merges into the other by insensible gradations. Nevertheless, there are some general physical and chemical tests by which one can be more or less distinguished from the other. These give us some insight into the nature of valence bonds in compounds of the higher order.

(*i*) *Simple Molecular Compounds.*

The typical representatives of this class are the salt hydrates and the double salts, viz., $FeSO_4.7H_2O$, $CuSO_4$ $5H_2O$, $K_2SO_4.Al_2(SO_4)_3$. 24 H_2O, KCl. $MgCl_2.6H_2O$, etc. The presence of the individual constituent ions is easily detectable in their solution. Hence the binding force between the different types of molecules is one of weak electrostatic character, which easily disappears in solution. The formation of salt hydrates is only a case of ionic hydration in the solid state, with the water dipoles orientated and held in equilibrium around the cation. In double salts like alum, the anionic groups are in a similar manner distributed symmetrically around the polyvalent cation, Al^{+++}. The water dipoles may evidently attach themselves both to the positive and the negative ions.

(*ii*) *Complex Molecular Compounds.*

That there are two types of complex compounds can easily be demonstrated. The one, the imperfect type, forms, as it were, a transition between the simple molecular compounds and the perfect complexes. A large number of metallic ammines like $CuSO_4.5NH_3$, $CuSO_4.4NH_3$, $NiCl_2.6NH_3$, $NiCl_2.4NH_3$, $AgCl.NH_3$, etc., belongs to this class. Complexes of the type M_2BeF_4, K_3FeF_6, $KHgI_3$, $KCdI_3$, K_2HgI_4, etc., also come under the same category. They are partially dissociated into their components in solution, hence the usual analytical tests often fail to detect their presence. Physical methods, involving measurements of colour change, absorption spectra, electrolytic dissociation, distribution ratio, migration number, etc., are, therefore, more relied upon in these cases. Their co-ordination number is variable, depending on external circumstances. This is illustrated by the stepwise decomposition of certain metallic ammines with rise of temperature[59]. The composition of zincammine chloride at different temperatures is given below:

$ZnCl_2$	..	**10**	**6**	**4**	**2**	**$1NH_3$.**
Temp.	..	**−62°**	**23°**	**54°**	**260°**	**430°C.**

In contrast to this, there are compounds which give no characteristic chemical tests for atoms or groups inside the

complex zone, and in which the co-ordination number for any given central atom of a definite valency has a fixed value. Any attempt to alter this number leads to the complete disruption of the complex; only an exchange of different groups inside the co-ordination zone is, however, permissible. Thus, we have got a whole series of platinum compounds of the following character:

$[Pt(NH_3)_6]^{+4}Cl_4$,	$[Pt(NH_3)_5Cl]^{+3}Cl_3$,	$[Pt(NH_3)_4Cl_2]^{+2}Cl_2$
523	404	229
$[Pt(NH_3)_3Cl_3]^{+1}Cl$,	$[Pt(NH_3)_2Cl_4]^0$,	$[Pt(NH_3)Cl_5]^{-1}K$,
97	0	108·5
	$[PtCl_6]^{-2}K_2$.	
	256	

In these, the tetravalent platinum atom serves as the central atom of the complex. The figures under the formulæ indicate molecular conductivity at 25° and 1000 dilution. The atoms, groups or molecules lying inside the complex lose their individual chemical character and form collectively an independent radicle or ion with a fair degree of stability. The replacement of neutral ammonia molecules by atoms or groups like Cl, NO_2, SO_3, etc., which can normally exist as independent ions, affects the valency of the entire complex. Similar complexes are formed also by Co, Cr, Rh, Ir, etc. In combination with certain specific groups, Fe, Ni, Mn, Mo and W as well can behave likewise. The chemistry of the complex compounds, as is well known, was thoroughly studied and systematized by Alfred Werner, whose remarkable theory regarding the structure of these compounds, established on a solid foundation by his own numerous and illuminating works as well as by those of others of his school, still holds its undisputed position in this branch of our science. Fresh investigations, based on refined physical methods, have only served to confirm this famous theory. The co-ordination number for tervalent and tetravalent central atoms is usually six, while that for the bivalent ones is four. It rises, however, to eight in certain tetravalent molybdenum and tungsten compounds. The atoms or groups in a sixfold complex are arranged at the corners of a regular octahedron around the metallic atom at the centre, giving rise to *cis-trans* and optical isomerism under suitable conditions. The units in fourfold complexes are arranged at the four corners of a square in the same plane with the central metallic atom, which accounts for the *cis-trans* isomerism, also occurring among them.

Another important distinction between the two types of complexes is found in their magneto-chemical behaviour. This is only applicable to compounds with a paramagnetic

central atom. It has been observed that the magnetic susceptibility of imperfect complexes is more or less identical with that of the simple ions as obtain in the hydrated or anhydrous salts of the elements, forming the central atoms of these complexes. On the other hand, the paramagnetic susceptibility of a simple ion undergoes a profound alteration, often changing into diamagnetic character, when the ion forms the centre of a perfect complex.

This is clearly shown in the following examples [60] :—

Substance.	$\eta_{Weiss.}$	Substance.	$\eta_{Weiss.}$	Substance.	$\eta_{Weiss.}$	Substance.	$\eta_{Weiss.}$
$FeCl_2$	25·7	$FeCl_2 \cdot 4H_2O$	26·2	$[Fe(NH_3)_6]Cl_2$	26·3	$K_4[Fe(CN)_6]$	Dia
$CoCl_2$	24·8	$CoCl_2 \cdot 6H_2O$	24·0	$[Co(NH_3)_6]Cl_2$	26·2	$[Co(NH_3)_6]Cl_3$	Dia
$MnSO_4$	28·3	$MnSO_4 \cdot 4H_2O$	29·2	$[Mn(NH_3)_6]Br_2$	30·0	$K_4[Mn(CN)_6]$	10
$CoSO_4$	25·2	$CoSO_4 \cdot 7H_2O$	25·04	$[Co(NH_3)_6]SO_4$	24·6	$K_3[Co(CN)_6]$	Dia
$NiCl_2$	16·1	..	..	$[Ni(NH_3)_6]Br_2$	16·0	[Ni(Dimethglyox)$_2$]	Dia
$Fe_2(SO_4)_3$	29·0	..	..	..	..	$K_3[Fe(CN)_6]$	10
$CuSO_4$	10	$CuSO_4 \cdot 5H_2O$	9·5	$[Cu(NH_3)_4]SO_4$	8·98	..	..
$FeSO_4$	25·5	$FeSO_4 \cdot 7H_2O$	25·8	..	..	[Fe(Dipy)$_3$]Cl_2	Dia

The above two types of complex compounds were named 'Associated' and 'Penetration' complexes by the present writer in a previous paper.[61] The associated complexes correspond to the partial or imperfect type, and the penetration complexes to the complete or perfect type.

The Nature of the Chemical Bond in Compounds of the Higher Order.

We shall now proceed to discuss the nature of the binding in these three types of molecular compounds. In the simple molecular compounds, like hydrates and double salts, the binding, as already stated, is a purely electrostatic one. The assumption, that the molecules are here linked together by co-ordination bonds of shared electrons, as advocated by Sidgwick,[62] cannot be accepted in view of several convincing evidences to the contrary. In the first place, the number of saturated molecules in a simple molecular compound is sometimes too large to permit of such an assumption. Thus, compounds of hexamethylene tetramine with several co-ordinatively saturated complex cyanides have been obtained, which crystallize with a much larger number of water molecules than what is contained in the original salts. Hexamine itself has got no water of crystallization. Some typical instances of this class of compounds are given below.[63]

Original salts.	Hexamine compounds.
K_3FeCy_6	$K_3FeCy_6 . C_6H_{12}N_4 . 9H_2O$
K_3CoCy_6	$K_3CoCy_6 . C_6H_{12}N_4 . 6\frac{1}{2}H_2O$
$Na_2Fe(NO)Cy_5 . 2H_2O$	$Na_2Fe(NO)Cy_5 . C_6H_{12}N_4 . 11H_2O$
$Mg(NH_4)_2FeCy_6$	$Mg(NH_4)_2FeCy_6 . C_6H_{12}N_4 . 10H_2O$
$CaKFeCy_6 . 3H_2O$	$CaKFeCy_6 . C_6H_{12}N_4 . 6H_2O$

If neither K_3FeCy_6 nor hexamine, for instance, can separately act as acceptors or donors of electrons towards water molecules, there is no reason to suppose that they would behave otherwise when present together. The same argument can be equally advanced in the case of the following hydrated compounds, formed from aqueous solution by the union of two different co-ordinatively saturated complex ions of the Werner type.

$$[Cr(en)_2(OH_2)_2] . [Cr(C_2O_4)_3], 2H_2O; \quad [Co(en)_3] . CrCy_6, 2H_2O;$$
$$[Co(en)_3] . [Cr(C_2O_4)_3], 6H_2O; \quad [Co(en)_3]_2 . (PtCl_6)_3, 12H_2O;$$
$$[Co(NH_3)_6]_2 . (Pt\ Cl_6)_3, 21H_2O.$$

The formation of the above described hydrated compounds is best explained on the basis of an electrostatic attraction between the salt ions and water dipoles. In the case of hydrated hexamine compounds, the addition of urotropine molecules seems to increase the ionic attraction for the dipoles of water by altering the electric field of force around the ions. Secondly, the hydrated salts and simple molecular compounds, so far as they have been investigated, fail to give any Raman lines corresponding to a real electronic bond between the constituent molecules.

The nature of the linkage in associated or imperfect complexes may be regarded as a transition between the heteropolar and homopolar bindings, in agreement with their physical and chemical properties. The Raman spectra give some indication of the formation of a weak duplet bond of electrons between the central atom and the co-ordinated units in these compounds.[64] Absorption bands of the hydrated simple salts of several elements of the transitional groups have also been found to differ completely from those of their complex compounds of the imperfect and perfect types, the latter two resembling each other more or less closely in this respect.[65] The preparation of several optically active modifications of imperfect complexes lends support to this view.[66]

The exceptional chemical properties, the directional character of the valence force, unalterable value of the co-ordination number, and the variation of magnetic properties in several cases, are the characteristic features of the perfect or penetration complexes; and by these they are easily distinguished from the other two types of molecular compounds. The units in these complexes are evidently held to the central atom by true co-ordination bonds of shared electrons, the strength of the binding being more intense than what obtains in imperfect complexes. The K-absorption bands of the chlorine atom of several complex compounds, as previously observed, furnish a strong evidence in support of this view. The Raman lines for $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_5Cl]Cl_2$ only confirm the same.[67] The following table gives a comparative account of the frequency shifts in the Raman spectra of a number of simple[37] and complex compounds.[64]

Substance.	$\Delta\nu$ in cm^{-1}.	Bond.
$[Cu(NH_3)_4]SO_4$	403	Cu-N
$[Cu(NH_3)_4]Cl_2$	408	Cu-N
$[Zn(NH_3)_6]SO_4$	427	Zn-N
$[Cd(NH_3)_6]Cl_2$ .. .	340	Cd-N
$[Co(NH_3)_6]Cl_3$	480; 565	Co-N
HI	2233	H-I
HBr	2479	H-Br
HCl	2780	H-Cl
H_2	4155	H-H
Cl_2	556	Cl-Cl
N_2	2329	N-N
O_2	1552	O-O
Amine	3322	N-H
PCl_3	512	P-Cl

Assuming that the magnitude of the frequency shift is proportional to the strength of the binding, as a glance at the values for simple compounds would indicate, we may conclude that the co-ordination linkage is somewhat stronger in perfect complexes than in imperfect ones.

Electronic Constitution of Complex Compounds.

In a complex ion like $[Co\ (NH_3)_6]^{+++}$, the central cobalt ion is linked to the nitrogen atoms of ammonia molecules by means of co-ordination bonds or semipolar linkages, the nitrogen atom contributing both the electrons of the shared pair. Sugden,[68] however, suggests that the formation of co-ordination bond consists in the sharing of one electron only, supplied by the co-ordinated units. This is rather inconsistent with the stability of some of these compounds. Besides, in the light of recent representation of the chemical bond by London, it is indeed difficult to follow how the spin moment of a single electron could balance that of two other different electrons—one of the central atom and the other of the contributing unit.

Assuming therefore that the co-ordination bond is one of duplet type, it remains still to account for the diminution of magnetic moment of the central ion in its perfect complexes. Bose[69] has suggested an interesting scheme in which some of the co-ordinated units are linked to the central atom in such a way that one of the duplet of electrons in each case is taken up in the inner incomplete shell of the atom, while the other is raised to a higher level. The rest of the co-ordinated units similarly contribute electrons to these higher levels, whereby the latter are completely filled up. The

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distribution of the electrons for $[Co(NH_3)_6]Cl_3$ and K_3CrCy_6 is thus depicted by him:

Co	Cr
3d 4p 4S	3d 4p 4S
+ +	
+ ● NH_3 ● ● NH_3 ●	+ ● CN ● ● CN +
+ ● NH_3 ●	+ ● CN ● ● CN +
+ ● NH_3 ●	+ ● CN ● ● CN
+ ● NH_3 ● ● NH_3 ●	+

+ =electrons originally belonging to the central atom;
● =electrons originally belonging to the co-ordinated unit.

In the cobalt complex, all the shells of the central atom are shown to be completely filled up, which readily accounts for the diamagnetic character of the compound. In chromicyanide, however, the 3-d level of the chromium atom contains only seven electrons instead of its full quota of ten; hence the compound, according to Pauli's principle, should give a magnetic moment of $10-7=3$ Bohr's magneton, as is actually observed. Bose, however, leaves the nature of the co-ordination bond or the mechanism of the sharing of electrons undefined. For, if in Bose's scheme of representation the binding would have been of homopolar type, then, after London-Heitler's theory, many of these complex compounds should have shown quite different values of magnetic moments from those actually found. The scheme further presents certain difficulties when considered from a chemical standpoint. Thus, it is evident from the electronic distribution for the cobalt-hexammine complex that the nitrogen atom of each ammonia molecule must enlarge its usual stable shell of eight electrons to one of ten, if a chemical bond of shared electrons is really to be formed. Besides, the distribution of the six co-ordinated groups among the different levels of the central atom renders it extremely difficult in many cases to account for the stereo-chemical properties of inorganic complex compounds, as established by Werner. Bose's scheme is based mainly upon the rule previously suggested by him and by Welo and Baudisch, which states that the magnetic moment of a complex, expressed in Bohr's magneton value, is equal to the difference between the atomic number of the nearest inert gas and the '*effective atomic number*' of the central atom.[70] The term '*effective atomic number*' has been defined by Sidgwick as the total number of electrons around the nucleus of an atom in combination.[71] That this rule does not hold good in many complex nickel and cobalt compounds, was previously pointed out by the present writer.[72] A few cases of such discrepancy are given below:

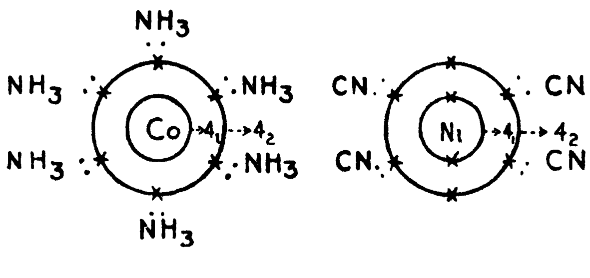
Substance.	η_{Bohr} (nearest).	η_{Bohr} after Bose and Welo's rule.
$CoSO_4 . 6NH_3$	4	1
$CoSO_4 . 3N_2H_4$	4	1
$CoCl_2 . 2N_2H_4$	4	3
Cobalt (Co^{II}) biguanide	1	3
Nickel dimethylglyoxime	Dia	2
Nickel dicyandiamidine	Dia	2
$K_2NiCy_4 . 2H_2O$	Dia	2
Nickel Rubeanate	Dia	2

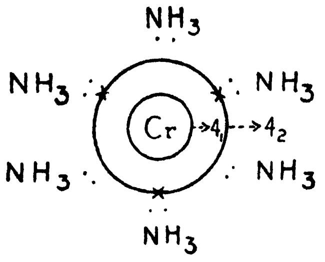
From a consideration of the chemical and magnetic properties of the elements of the first transitional series, a scheme of electronic distribution in perfect complexes was suggested by the writer some time ago.[60] With slight modifications in the light of newer knowledge it may now be represented as follows. The valence bond in complex compounds is regarded to be of the co-ordinate covalent type, both the electrons of the shared pair in each bond being contributed by the co-ordinated unit or atom. The electrons in the incomplete shell of the central ion take, therefore, no part in the bond formation. For the sake of simplicity, it is assumed that the central atom acts as a co-ordination centre, originally in the form of an ion or a charged particle. The following table gives the total number of electrons, the number present in the incomplete shell, and the magnetic moment in Bohr's magneton value for a number of simple ions of the elements of the first transitional group. The magnetic moments of the corresponding complexes are also shown for comparison.

Ions.	Total number of electrons.	Number of electrons in the incomplete shell.	η_{Bohr} (nearest) in the simple ions.	η_{Bohr} (nearest) in imperfect complexes.	η_{Bohr} (nearest) in perfect complexes.
Cr^{II}	22	4	4	4	2
Cr^{III}	21	3	3	3	3
Mn^{II}	23	5	5	5	1
Mn^{III}	22	4	4	4	2
Fe^{II}	24	6	4	4	Dia
Fe^{III}	23	5	5	5	1
Co^{III}	24	6	..	..	Dia
Co^{II}	25	7	4	3·8-4	1 and Dia
Ni^{II}	26	8	2·4	2·4-2	Dia
Cu^{II}	27	9	1	1	1
Cu^{I}	28	10	Dia	Dia	Dia

The magnetic moments of the simple ions and of their imperfect complexes are almost identical, but differ widely from those of the perfect complexes. This indicates clearly that in the formation of strong co-ordination bonds in perfect complexes, the electrons in the incomplete 3_3-shell of the ions are disturbed or excited. It is assumed that they are thereby raised to 4_2- and 4_1-quantum levels. With this simple assumption the magnetic moments of the perfect complexes of these transitional elements can be easily accounted for, on the basis of Pauli's Exclusion Principle, taking note of Bose-Stoner's suggestion that only the spin moments of the electrons are effective here—the orbital moments being neutralized as the result of interaction with the co-ordinated units.[41] In all the perfect complexes with the exception of Co^{II} and Ni^{II} compounds, the electrons of the 3_3-shell of the central atom are excited by the energy of co-ordination to the 4_2-level, which can be filled up by six electrons. In the case of perfect Co^{II} and Ni^{II} complexes, the electrons are raised to both 4_1- and 4_2-levels. Values calculated on the basis of the above representation agree remarkably well with experimental results. The only exception hitherto found is K_4CoCy_6 which is diamagnetic, though, according to the theory, it should give a magnetic moment of one Bohr's magneton. This anomaly can, however, be explained on the supposition that the compound is bimolecular with a sort of metallic bond between the two molecules, so that the odd electrons of the latter mutually balance by coupling of their spin moments. The eight or twelve shared electrons from the four or six co-ordinated units, as the case may be, are arranged symmetrically in the form of a more or less stable external shell around the central atomic core. It will serve no useful purpose to assign arbitrarily any definite quantum values to them. The following diagrammatic representation of the external electronic system in perfect complexes would make this idea clear.

$[Co(NH_3)_6]^{+++}$ $[Ni(CN)_4]^{--}$





$$[Cr(NH_3)_6]^{+++}$$

× electrons belonging to the central atom.
• electrons belonging to the co-ordinated atom.

The constitution of metallic carbonyls may also be similarly represented.

In associated or imperfect complexes of this group of elements, the energy of co-ordination is rather inadequate to excite the electrons of the central atom out of their normal 3_3-level to 4_2- and 4_1-quantum groups; so the magnetic moment of the latter remains unaffected in these complexes.

The data, concerning the magnetic measurements for the simple and complex ions of the elements of other transitional series, are not yet sufficiently large to permit of any useful discussion here.

In all the three types of molecular compounds discussed above, the source of attraction is the charge on the central ion; the units attracted are either ions, or molecules with dipole moment. The firmness of binding increases gradually with the charge on the atoms concerned, and diminishes with the distance between them. The attraction exerted by the central ion leads to a deformation of the electronic orbits of the co-ordinated units. With progressive deformation, the weak electrostatic bond in the case of simple molecular compounds is gradually transformed into a non-polar or rather semipolar co-ordination bond in imperfect and perfect complexes. A quantitative distinction ultimately assumes a qualitative aspect. Thus, the nature of the binding with all its varieties, as perceived in the compounds of the first order, finds its replica in those of the higher order.

The Co-ordination Number and its significance.

From what has been said above, the significance of the co-ordination number follows without much difficulty. Kossel[4] developed quantitatively by calculation the condition of existence of complex ions on the basis of electrostatic

forces, and, from a consideration of the energy of formation for a number of possible types of association between a charged central atom and any given ion with opposite charge, determined the composition and structure of the most stable type corresponding to the maximum energy of association. This gave the co-ordination number of the central ion, which was found to agree satisfactorily with facts. He concluded that the maximum co-ordination number of an atom increases with its valency. Magnus[73] extended Kossel's method by taking into account the important role played by the volume of the central atom and of the associated units. He applied it further to the case of molecular complexes in which, instead of simple ions, ionic groups or neutral molecules with dipole moment, like CN^-, NH_3, H_2O, etc., enter into co-ordination. The energy of formation, **U**, in these cases is given by the following equation after Magnus:

$$U = pn_1\frac{e^2}{r} \cdot \frac{d}{r}\left(n - \frac{1}{2}n_1S_p \cdot \frac{d}{r}\right)$$

where p = number of the co-ordinated units,
n_1e = charge of the dipoles,
ne = charge on the central atom,
d = dipole length,
r = distance between the nucleus of the central atom and the middle point of the dipoles.
S_p = the 'Abschirmung' constant (screening factor) of the associated p dipoles.

The maximum value of **U** gives the most stable type of complex. The results, which were found to give closer agreement with experimental values, indicate that the co-ordination number of an atom increases not only with its valency, but also with its volume. Similar conclusions have also been arrived at by Biltz and Grimm,[74] who calculated the lattice energy of the ammoniates from a knowledge of the heat of formation of the ammines, and the lattice energy of the simple salts. Identical views have recently been expressed again by Garrick,[75] who, like Magnus, has determined the maximum co-ordination number of an ion from a consideration of the electrostatic attraction between the charged central atom and the dipoles of water or ammonia, the mutual repulsion of the dipoles, and the quasi-elastic energy of polarisation.

Conclusion.

Finally, it should, however, be pointed out that the various physical and chemical properties, which serve as criteria for determining the nature of the chemical bond, do not all lead to the same conclusion. The question, whether

the transition between electrovalency and covalency occurs *per saltum* or gradually, can be decided one way or the other, according as the method, employed for measuring the change in any particular property serving as an index of the transition, is sufficiently sensitive or not. Thus, the photochemical decomposition of gas molecules, crystalline structure, magnetic susceptibilities, Raman spectra and X-ray absorption indicate an abrupt transition between the two types of valency. On the other hand, molecular refraction, dipole moment, absorption in the visible and ultra-violet region, electrolytic dissociation, volatility, solubility, lattice energy, etc., point definitely to a gradual transformation. In fact, there seems to be no real distinction between a continuous and a discontinuous change. The same phenomenon may appear to us as continuous or discontinuous, depending on the fineness of our sense and instrument of observation, as well as upon the selection of the property characterising the phenomenon. It is, therefore, more appropriate, though apparently enigmatical, to state that in all natural processes there is a continuity in discontinuity or a discontinuity in continuity.

In this short report I have not been able to give more than a very brief account of the various lines of investigations, through which a solution of the problem of valency and the structure of molecules is being attempted. As to a more detailed discussion, I plead my own incompetency in respect of some, and the limitation of time with reference to others. I have merely endeavoured to indicate the tremendous transformations that have occurred in our conception of valency and molecular constitution, as a result of the recent phenomenal progress in physical science, regarding the knowledge of atoms and molecules. Though no finality in this respect can ever be claimed, since knowledge has no end, still it is no exaggeration to state that we have started our journey well and in the right direction, with many new rich aspects of truth unfolding before us.

REFERENCES.

1. Bohr, *Nature* *112* (1923), 29.
2. Stoner, *Phil. Mag.* *43* (1924), 719;
   Main Smith, *Chem. and Ind.* *43* (1924), 323.
3. Hund, *Zeit. Physik* *33* (1925), 345; *34* (1925), 296.
4. Kossel, *Ann. d. Physik* *49* (1916), 229.
5. Lewis, *J. Amer. Chem. Soc.* *38* (1916), 762.
6. Langmuir, *ibid.* *41* (1919), 868, 1543.
7. Lowry, *Trans. Farad. Soc.* *18* (1923), 285;
   Sugden, Reed and Wilkins, *J. Chem. Soc.* *127* (1925), 1525.
8. Sidgwick, *J. Chem. Soc.* *123* (1923), 725.
9. Noyes, *J. Amer. Chem. Soc.* *39* (1917), 879;
   Knorr, *Zeit. anorg. Chem.* *129* (1923), 109;
   Sidgwick, *Trans. Farad. Soc.* *19* (1923), 469;
   Butler, *ibid.* *21* (1925), 349.

10. Fajans, *Naturwiss.* *11* (1923), 163.
Zeit. Kristallog. *61* (1925), 18;
Zeit. Elektrochem. *34* (1928), 502;
Fajans and Joos, *Zeit. Physik* *23* (1924), 1.
11. Thomson, *Nature* *120* (1927), 802;
Proc. Roy. Soc. *A 119* (1928), 651.
12. Sommerfeld, *Zeit. Elektrochem* *34* (1928), 428.
13. London and Heitler, *Zeit. Physik* *44* (1927), 455;
Heitler, *Zeit. Elektrochem.* *36* (1930), 640;
London, *Zeit. Physik* *46* (1928), 465.
14. Pauli, *Zeit. Physik* *31* (1925), 765.
15. Sommerfeld, *Ber.* *61* (1928), 1171.
16. Biltz and Klemm, *Zeit. anorg. Chem.* *162* (1926), 267.
17. Grimm and Sommerfeld, *Zeit. Physik* *36* (1926), 36;
Grimm, *Zeit. Elektrochem.* *34* (1928), 430.
18. Grimm and Herzfeld, *Zeit. Physik* *19* (1923), 141;
Zeit. angew. Chem. *37* (1924), 219.
19. Goldschmidt, *Trans. Farad Soc* *25* (1929), 253;
Zeit. Elektrochem *34* (1928), 454.
20. Sugden, *J. Chem. Soc.* *125* (1924), 1185,
Sugden, Reed and Wilkins, reference 7, p. 1525, 1868, 2517;
Sugden, *The Parachor and Valency*, 1930.
21. Debye, *Physikal. Zeitschr.* *13* (1912), 97,
Zeit. Elektrochem *34* (1928), 450.
Dipolmoment und Chemische Struktur, 1929.
22. Vorlander, *Ber.* *52* (1919), 263,
Lapworth, *J. Chem. Soc.* *121* (1922), 416,
Kermack and Robinson, *ibid.* *121* (1922), 427;
Lapworth and Robinson, *Trans. Farad. Soc.* *19* (1923), 503;
Lowry, *Bull. Soc. Chim.* *4* (1921), 35. 815, 905;
J. Chem. Soc. *123* (1923), 822
23. Sidgwick, *The Electronic Theory of Valency*, (1927), 132;
Zeit. Elektrochem. *34* (1928), 449;
Report, British Association (1927), 27.
24. Lindh, *Compt. Rend.* *172* (1921), 1175; *175* (1923), 25;
Zeit. Physik *31* (1925), 210
25. Stelling, *Ber.* *60* (1927), 650.
Zeit. Elektrochem. *34* (1928), 520, *36* (1930), 608.
26. Franck, *Trans. Farad. Soc.* *3* (1925), 21;
Zeit. Elektrochem. *36* (1930), 581.
Naturwiss. *10* (1931), 217.
27. Dutta and Saha, *Nature* *127* (1931), 625.
28. Hantzsch, *Ber.* *58* (1925), 612
29. Scheibe, *Zeit. Elektrochem.* 34 (1928), 497.
30. Ephraim and Bloch, *Ber.* *59* (1926), 2692; *ibid.* *61* (1928) 65.
31. Ephraim and Rây, *Ber.* *62* (1929), 1509.
32. *Ibid.* 1520, 1639.
33. Quill, Selwood and Hopkins, *J. Amer. Chem Soc.* *50* (1928), 2929,
Selwood, *ibid.* *52* (1930), 3112, 4308; *53* (1931), 1803.
34. Raman, *Trans. Farad. Soc.* *25* (1929), 781;
Raman and Krishnan, *Indian J. Physics* *2* (1928), 399; *Proc. Roy. Soc.* 122 (1929), 23;
For a complete report on Raman spectra see
Smekal, *Zeit. Electrochem.* *36* (1930), 618;
Kohlrausch, *Physikal. Zeitschr.* *32* (1931), 385;
For a complete bibliography on the subject see
Bhagavantam, *Indian J. Physics* *5* (1930), 257.
35. Krishnamurti, *Indian J. Physics* *5* (1930), 113, 651.
36. Daure, *Compt. Rend.* *187* (1928), 940.
37. Kohlrausch, *Physikal. Zeitschr.* *32* (1931), 385.
38. Pal and Sengupta, *Indian J. Physics* *5* (1930), 611.

39. Rao, *Nature 124* (1929), 763; *Proc. Roy. Soc.* A *127* (1930), 279;
   Woodward, *Physikal. Zeitschr. 32* (1931), 212.
40. Hund, *Zeit. Physik 33* (1925), 855.
41. Bose, *ibid. 43* (1927), 864;
   Stoner, *Phil. Mag.* 8 (1929), 250.
42. Pauling, *J. Amer. Chem. Soc. 53* (1931), 1367.
43. Klemm, *Zeit. angew, Chem. 44* (1931), 254.
44. Bose, *Nature 125* (1930), 708.
45. Pascal, *Ann. Chim. Phys. 19* (1910), 1; *25* (1912), 289; *29* (1913), 218.
46. Phillips, *J. Chem. Soc. 127* (1925), 2552;
   Harrison, Kenyon, and Phillips, *ibid.* (1926), 2079;
   Clarke, Kenyon and Phillips, *ibid.* (1927), 188.
47. Sugden, Reed and Wilkins, Reference 7.
48. Sugden, *The Parachor and Valency* (1930), 130;
   Prideaux, *Chem. and Ind. 42* (1923), 672.
49. Sidgwick and Barkwirth, *J. Chem. Soc.* (1931), 807.
50. Sidgwick, *The Electronic Theory of Valency* (1927), 130.
51. Simons and Jessop, *J. Amer. Chem. Soc. 53* (1931), 1263.
52. London, *Zeit. Physik 46* (1928), 465.
53. Lewis, *Valence and the Structure of Atoms and Molecules* (1923), 105, 113.
54. Sugden, reference 48, p. 201.
55. Wiberg, *Zeit. anorg. Chem. 173* (1928), 199; *179* (1929), 309;
   Ephraim, *Helv. Chim. Acta, 11* (1928), 1094.
56. Reference 50, p. 103.
57. Eastman, *J. Amer. Chem. Soc. 44* (1922), 438;
   Hellriegel, *Zeit. anorg. Chem. 185* (1929), 65;
   Müller, *Zeit. Elektrochem. 13* (1925), 382;
   Zeit. anorg. Chem. 176 (1928), 205.
58. *Atomic Theory*, A. Hass-translated by Verschoyle (1927), 75, 135.
59. Biltz and Hüttig. *Zeit. anorg. Chem. 123* (1922), 42.
60 Rosenbohm, *Zeit. Physikal. Chem. 93* (1919), 693;
   Rây and Bhar, *J. Indian Chem. Soc. 5* (1928), 497;
   Biltz, *Zeit. anorg. Chem. 170* (1928), 161.
61. Rây, *J. Indian Chem. Soc. 5* (1928), 73.
62. Sidgwick, *The Electronic Theory of Valency* (1927).
63. Rây and Sarker, *J. Chem. Soc. 119*, (1921), 390;
   Barbieri, *Gazzetta. Chim. Ital. 60* (1930), 229.
64. Joos and Damaschun, *Physikal. Zeitschr. 32* (1931), 553.
65. Samuel, *Zeit. Physik 70* (1931), 43.
66. Mills and Gotts, *J. Chem. Soc.* (1926), 3121;
   Wahl, *Ber. 60* (1927), 399;
   Rosenhaim and Plato, *Ber. 58* (1925), 2000;
   Rosenhaim, *Zeit. anorg. Chem. 196* (1931), 160.
67. Bose and Dutt, *Nature 128* (1931), 725.
68. Sugden, reference 48, p. 138.
69. Bose, *Zeit. Physik 65* (1930), 677.
70. *Ibid.* 35 (1925), 213, 219.
71. See reference 8.
72. Rây and Bhar, reference 60.
73. Magnus, *Zeit. anorg. Chem. 124* (1922), 289.
74. Biltz and Grimm, *Zeit. anorg. Chem. 145* (1925), 63.
75. Garrick, *Phil Mag. 9* (1930), 131; *10* (1930), 76; *11* (1931), 741.

FURTHER REFERENCES.

Ephraim,
'*Chemische Valenz und Bindungs-lehre*' *1928*.
Müller,
'*Der Aufbau der Chemischen Verbindungen*' (*Molekülbau*), *Ahrens Sammlung* vol. *30* (1928), 1.

Stoner,
'*Magnetism*' (1930);
'*Magnetism and Atomic Structure*' (1926).
Werner,
'*Neuere Anschauungen auf dem Gebiete der anorganischen Chemie*', edited by Pfeiffer (1926).
Weinland,
'*Einführung in die Chemie der Komplex-Verbindungen*' (1924).

Section of Chemistry.

Abstracts.

1. Relation between the absorption spectra and the magnetic susceptibilities of paramagnetic solutions.

D. M. BOSE *and* S. DATTA, Calcutta.

It is shown in a note communicated to the Physical Section of this Congress that associated complexes of paramagnetic ions like

$$[Ni(H_2O)_6]^{++}, [Ni(N_2H_4)_2]^{++}, [Ni(NH_3)_6]^{++} \text{ etc.}$$

are formed by the interpenetration of the electron charge of the paramagnetic ion with those of the surrounding dipole molecules forming the complex. The magnetic moment of the ion present in the complex can in general be represented by a formula proposed by Van Vleck

$$\mu = \sqrt{4s(s+1)+l(l+1)}$$

where s=the resultant of the spin moments of the electron,
l= „ „ orbital moments The more intimate the interpenetration, the less possible it is for the orbital moment of the paramagnetic ion (represented by the quantum number l) to orient itself in the external magnetic field and therefore to contribute its full quota to the magnetic moment of the latter. The measure of the association affinity between the ion and the dipole molecules surrounding it, is the deviation of the magnetic moment of the complex from the value calculated according to the above formula.

On the other hand if νg is the absorption frequency of the paramagnetic ion in the gaseous state and νs that of the same ion when forming part of a complex radicle, then it can be shown that $h\nu s = h\nu g + w$; where w is the work done in breaking up the association of the ion with the surrounding dipole molecules. Thus the strength of this association is manifested (i) by the deviation of the magnetic moment of the complex from the theoretical value to be expected for the simple ion and (ii) by the shift of the absorption spectra due to the complex, towards the violet side. It is shown for a number of aqueous solutions containing paramagnetic complex ions that such a correlation actually exists.

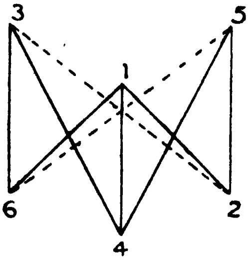
2. A new constitutional formula for benzene.

P. C. GUHA, Bangalore.

The merits and demerits of the various proposed structural formulæ for benzene are well known. The following new structure is tentatively put forward as explaining most of its well known chemical properties.

In the new formula, the six carbon atoms are placed at the corners of a regular prism, as in the well known prism formula of Ladenburg, where are to be found six meta and three para linkages. In the proposed formula six ortho and three para linkings are postulated, diagonal corners of the prism faces being ortho and those occupying the ends of the vertical

edges being para. The meta linkings are dispensed with. The new formula, in perspective, may be represented as,



A critical discussion of the chemical and physical properties of benzene with reference to the proposed new formula and the older formulæ is made.

3. Raman spectra of optical isomers.

GAJANAN V. NEVGI *and* S. K. KULKARNI JATKAR, Bangalore.

The Raman spectra of the following optical isomers have been studied :—(1) *d.* Pinene, (2) *l.* pinene, (3) *d.* Sabinene, (4) *l.* Sabinene, (5) *d.* Δ_3 carene, (6) *l.* Δ_3 carene. A special tube had to be designed to give satisfactory results with 7·8 c.c. of pure substances available. The spectra of *d.* and *l.* Pinene have been fully analysed and have been found to be identical except some variations of the intensities. In both the pinenes a characteristic band of definite structure has been observed which contains a series of 8 sharp lines in agreement with the observations by Bonino and Cella (*Nature 126*, p. 915; 1930). The spectra of the sabinens and also of Δ_3 carenes are also identical for the *d.* and *l.* forms.

Some of the shifts have been identified with definite chemical linkages.

4. Raman effect in some reduced derivatives of benzene.

GAJANAN V. NEVGI, Bangalore.

Raman spectra of the following substances have been studied :—(1) cyclohexane (2) cyclohexene (3) methyl cyclohexane (4) cyclohexyl acetate (5) cyclohexyl propionate (6) cyclohexanol (7) orthomethyl cyclohexanol (8) meta methyl cyclohexanol (9) para methyl cyclohexanol (10) cyclohexanone (11) ortho methyl cyclohexanone (12) para methyl cyclohexanone.

The spectrum of cyclohexanol is not much different from its homologues. The isomers o. m. and p. of methyl cyclohexanols differ in their spectra only in the smaller shifts. The longer shifts are accompanied by changes in intensities and not in value. There are marked differences in the o. and p. methyl cyclohexanones. Some of the shifts have been identified with definite chemical bonds.

5. Raman spectra of amyl alcohols.

GAJANAN V. NEVGI *and* S. K. KULKARNI JATKAR, Bangalore.

The Raman spectra of the isomeric amyl alcohols have been studied using 4046 and 4358 as exciting lines from a 3,000 c.p. Heraus Mercury lamp and the shifts obtained give the following wave lengths in Å. U for the infra-red absorption :—

(1) N. butyl carbinol.
3·37, 3·41, 3·48, 6·9, 7·7, 8·98, 9·4, 9·88, 10·43, 11·2, 11·83, 12·98.

(2) Isobutyl carbinol.
3·38, 3·42, 3·48, 6·87, 7·61, 8·82, 9·41, 10·26, 10·49, 11·1, 12·03, 13·07.

(3) Sec. butyl carbinol.
3·37, 3·42, 3·48, 6·84, 8·86, 9·48, 9·77, 10·39, 11·0, 11·95, 12·97, 21·9, 26·7.

(4) Methyl n. propyl carbinol.
3·37, 3·42, 3·48, 6·91, 7·69, 8·91, 9·76, 10·54, 11·25, 12·05, 20·1, 29·9.

(5) Diethyl carbinol.
3·37, 3·42, 3·48, 6·88, 7·65, 8·88, 9·69, 10·58, 11·93, 13·5, 20·5, 30·9.

(6) Dimethyl ethyl carbinol.
3·36, 3·42, 3·48, 6·86, 7·76, 8·44, 9·48, 10·74, 11·36, 13·76, 19·0, 28·0, 38·8.

The differences among various isomers are shown in the long wave lengths, i.e., beyond 13μ. The shift 770 $\Delta\nu$. attributed to the OH group in the amyl alcohols is present in all the primary alcohols but its value in the secondary alcohols is less and still less in tertiary amyl alcohol. The following are the values of the shifts: (1) 770, (2) 765, (3) 771, (4) .. , (5) 741, (6) 727.

The spectrum of tertiary amyl alcohol is much different from the rest, which is to be expected from its different chemical structure. Some of the shifts have been identified with definite chemical bonds.

6. A note on the anomalous x-ray spectra of the simple and the complex iodates of titanium and tin.

P. RÂY, Calcutta.

The simple and the complex iodates of titanium have been found to resemble the corresponding tin compounds in all chemical and physical properties including their molecular volume. The x-ray spectra of potassium stanni-iodate and potassium titani-iodate are perfectly identical, indicating a close isomorphous relationship. Curiously enough, the simple titanium iodate gives the same x-ray spectra as these two complex salts. What is still more strange, a stoichiometrical mixture of potassium iodate and titanium iodate gives an x-ray spectrum, in which all the lines due to titanium iodate vanish and even those of potassium iodate become very faint. No explanation can as yet be suggested for these anomalies.

7. Effect of mechanical and chemical colloidisation on the diamagnetism of antimony.

S. S. BHATNAGAR, R. N. MATHUR, *and* MULKH RAJ VARMA, Lahore.

The magnetic properties of elements in the colloidal state have seldom been investigated. In the case of antimony, however, it was found by some workers that the diamagnetism of this element decreases considerably on mechanical and chemical colloidisation. These experiments have been repeated but the results show that the fall in diamagnetism observed by previous workers is mostly due to the oxide formation. Antimony powders and sol contain enough of antimony oxides to be estimated by ordinary methods. Moreover, after washing the powders with suitable reagents to remove the oxides, practically no fall in diamagnetism is observed.

8. The dimorphism of trilaurin.

R. K. VALVEKAR *and* S. K. KULKARNI JATAKAR, Bangalore.

In continuation of the previous work (reported in Allahabad Science Congress, 1930) the cooling curve of specially purified trilaurin revealed the

temperature at which the molten liquid of the stable form changes into unstable form with absorption of heat before solidifying, the phenomenon having escaped the attention of previous observers as it could be ascribed to undercooling.

The heat of this transformation is being determined by the method of twin calorimeters.

9. The 'corona pressure' phenomenon in electric discharges due to alternating fields of low frequency.

S. S. Joshi, Benares.

It was observed incidentally that when an alternating P.D. of the order of 15,000 volts (r. m. s.) was applied to a gas at a moderate pressure contained in the annular space of two tubes sealed coaxially as in the Siemens' ozoniser, a sudden pressure rise, followed by a slower pressure change, was produced just after the secondary P.D. was switched on. Reverse series of pressure changes is produced soon after the cessation of the current. Results are obtained bearing on the nature of the initial pressure change.

10. Studies on the dependence of optical rotatory power on chemical constitution. Part XIII. Naphthylene derivatives of stereoisomeric iminocamphors and methylenecamphors.

B. Singh *and* Bhutnath Bhaduri, Cuttack.

Naphthylenediamines (*1*:*2* and *1*: *5*) have been condensed with camphorquinones (*d*, *l*, *dl*) and oxymethylenecamphors (*d*, *l*, *dl*). The rotatory powers of the enantiomers are found to be identical. The rotations of benzocamphanoquinoxalines (*d*, *l*) are so low that the sign of their rotations is reversed. *1* : *5* Naphthylenebisimino-, and *1* : *5* naphthylenebis-aminomethylene camphors are found to have much lower rotations than the corresponding *1* : *4* compounds. The introduction of an amino group in the 5 position of α-naphthyliminocamphor lowers the rotation and acetylation still further lowers the same. *1* : *5* Napthylenebisaminomethylenecamphor obeys the simple dispersion law.

11. Studies on the dependence of optical rotatory power on chemical constitution. Part XIV. Stereoisomeric amidomethylene-, and imido-methylenecamphors and their derivatives.

B. Singh *and* B. Bhaduri, Cuttack.

It is found that the rotatory dispersion of amidomethylene- and imidomethylene-camphors can be expressed by the one-term equation of Drude.

The rotatory dispersion of the *dextro* and *laevo* forms is identical, and this supports Pasteur's law of molecular dissymmetry.

Benzalamidomethylenecamphor has been obtained in three forms *d*, *l*. *dl*. Its specific rotatory power is more than twice as large as that of the amidomethylenecamphor.

The *internally compensated* imidomethylenecamphor was prepared in two ways by the condensation of (1) amidomethylene-*d*-camphor with oxymethylene-*l*-camphor and (2) amidomethylene-*l*-camphor with oxymethylene-*d*-camphor. The products were in both cases inactive and identical as they had the same m.p. and mixed m.p.

12. Studies on the dependence of optical rotatory power on chemical constitution. Part XV. Chloroaryl derivatives of stereoisomeric methylenecamphors.

B. SINGH *and* BHUTNATH BHADURI, Cuttack.

The chloro derivatives (*mono, di, tri*) of anilinomethylenecamphors (*d, l, dl*) have been prepared. The rotatory power of the optically active isomerides (*d, l*) determined in six solvents and for eight to nine wavelengths (λ=4800 to 6708 Å. U) are found to be identical and can be expressed by the one term simple dispersion equation of Drude,

$$[\alpha]=\frac{K}{\lambda^2-\lambda_0^2}$$

The polar effect as deduced from the electronic theory is traceable in optical activity; the replacement of a hydrogen atom by a negative group such as Cl, diminishes the rotation of the parent compound; further substitution by a similar group as in dichloro and trichloro derivatives of anilinomethylenecamphor results in progressive diminution of the rotatory power.

13. Studies on the dependence of optical rotatory power on chemical constitution. Part XVI. Bromo- and indoaryl derivatives of stereoisomeric methylenecamphors.

B. SINGH *and* BHUTNATH BHADURI, Cuttack.

The optically active (*d* and *l*) bromo- and iodoanilino methylenecamphors have identical rotation and are found to obey the simple dispersion law of Drude.

Substituent influence on rotatory power in the optically active compounds is represented by $H>CH_3>Cl>Br>I$; the series being identical with the polar series; positions of iodine and chlorine being interchanged. The influence of the solvents and position isomerism on rotatory power is discussed.

14. Studies on the dependence of optical rotatory power on chemical constitution. Part XVII. Nitro- and carboxyaryl derivatives of stereoisomeric methylenecamphors.

B. SINGH *and* T. P. BARAT, Cuttack.

The nitro and carboxy derivatives (*o, m, p*) of anilinomethylenecamphors (*d, l, dl*) have been prepared. The rotatory powers of the enantiomers are identical and can be expressed by the simple dispersion equation of Drude.

Substituent influence on rotatory power in the optically active compounds is represented by $NO_2>H>CH_3>Cl>Br>I$ for the *ortho* and *para* derivatives; COOH occupying an intermediate position varying with the nature of the solvent in which the rotatory power is determined. This series is, on the whole, nearly identical with the 'polar' one.

15. The refractive and rotatory dispersion in terpenes. Part I.

R. PADMANABHAN *and* S. K. KULKARNI JATKAR, Bangalore.

The optical dispersion of *d* and *l*-pinene, *d* and *l* sabinene and *d* and *l* Δ_3 carene, isolated in our laboratory from various essential oils and

purified by repeated distillation and crystallisation, has been studied in the visible and glass ultraviolet using the lines from the mercury arc, iron arc and a hot cathode helium arc, and was found to be normal. The rotatory dispersion was measured with a modified form of the three field polarimeter in conjunction with a constant deviation spectroscope and the refractive indices with the Pulfrich Refractometer.

Apparatus is being constructed to extend similar measurements in the ultraviolet where the above substances show absorption.

16. Influence of geometrical isomerism on optical rotation.

P. Neogi *and* A. K. Sen.

Salts of acids, which are geometrical isomers, with quinine, quinidine, cinchonine, cinchonidine, strychinine, morphine and brucine have been prepared and their optical rotation compared.

17. Dissosciation pressures of cadmium carbonate.

P. Y. Narayan, Bangalore.

The pressures of carbon dioxide in equilibrium with cadmium carbonate and cadmium oxide developed as a result of the dissosciation of the former are measured at different temperatures by the static method.

The results obtained agree very satisfactorily with the values calculated from the well known Nernst's approximation formula,

$$\log p = \frac{-Q}{4.571\ T} + 1.75 \log T + 3.2,$$

using Thomsen's value for the heat of dissosciation. The results, however, differ from the values obtained by Centnerszwer and Andrussov (Zeit. Physikal Chemie, *III*, 79, 1924) at low pressures.

18. The density and compressibility of sulphur hexafluoride.

G. Gundu Rao, K. L. Ramaswami, *and* H. E. Watson, Bangalore.

Sulphur hexafluoride has been prepared by the direct combination of sulphur with fluorine generated by the electrolysis of fused potassium bifluoride. The gas after long standing over strong alkali and drying, was purified by repeated fractional distillation at low temperatures.

The experiments were done in the same apparatus previously described (*Ind. Sc. Congress*, Sec. III, Abs. 215). The values of the compressibility coefficient A at $+25^\circ$ and -80° are respectively $0{\cdot}012 \pm {\cdot}001$ and $0{\cdot}045 \pm {\cdot}001$.

Work on the limiting density is proceeding with a view to redetermine the atomic weight of fluorine.

19. Variation of surface tension and viscosity of different solutions with dilution.

D. N. Chakravarti *and* U. D. Mukerji, Amraoti.

The surface tension and viscosity of the following sols were determined at different dilutions :—

(1) Ferric phosphate, (2) Ferric arsenate, (3) Ferric tungstate, (4) Ferric hydroxide, (5) Chromium arsenate, (6) Chromium hydroxide, (7) Arsenic sulphide, (8) Ceric hydroxide, (9) Aluminium hydroxide, (10) Zirconium borate, (11) Molybdic acid, (12) Antimonic acid.

It was found that the surface tension of the colloids increases with the decrease in the concentration whereas the viscosity decreases with the decrease of concentration. The change of surface tension with concentration can be expressed by the following empirical formula:—

$$S=S_0e^{A-BC^2},$$

where S=Surface tension of colloids, S_0=Surface tension of the medium, A and B are constants depending on the nature of the colloid, C=Concentration expressed in number of grams per litre.

In the case of viscosity also a similar formula, namely

$$\eta=\eta_0e^{A_1+B_1C^2}$$

holds good.

We have verified these equations with above solutions by plotting log S and log η against C^2 and in every case we get straight lines.

20. Solubility of silver chloride in water, nitric acid and dilute aqueous solutions of alkali nitrates.

P. C. DAVE *and* K. R. KRISHNASWAMI, Bangalore.

The solubility of coagulated silver chloride in H_2O, and in dilute aqueous solutions of HNO_3, KNO_3, $NaNO_3$ and NH_4NO_3 was determined in different concentrations of the solvent in the temperature-range 0—50, employing the nephelometric method. The results obtained are discussed in the paper.

21. Effect of polar and non-polar solvents and their mixtures on the solubilities of benzoic and salicylic acids.

P. G. DESAI, Bombay.

The solubilities of benzoic and salicylic acids have been determined in benzene, toluene, hexane, xylene, carbon-tetrachloride, chlorobenzene, nitrobenzene, chloroform, aniline, acetone, and methyl, ethyl, (normal) propyl and (normal) butyl alcohols and varying percentages of their mixtures.

It is found that in presence of varying percentages of the solvents, in certain mixtures, maxima are obtained when solubilities are plotted against percentage amounts of the solvents. Compound formation was also noticed in certain cases.

Work on the changes of the dipole moments of the mixtures of the solvents in presence of the solute is in progress.

22. Action of glycine and alanine on the insoluble salts of silver and lead.

H. M. MAPARA *and* A. M. PATEL, Bombay.

It was observed that, if to a solution of silver nitrate or lead nitrate there was added a solution of potassium chloride or bromide or iodide or chromate in quantity sufficient to produce precipitation, no precipitate was formed if there had been previously added to either reactant a definite amount of glycine or alanine. It was found that with the increase in the concentrations of the salt solutions of silver or lead, the amounts of glycine or alanine required also increased. The order of the amounts of glycine or alanine in the case of silver salts was as follows:—

$$AgCl>AgI>AgBr>Ag_2CrO_4$$

while in the case of lead salts

$$PbCl_2>PbCrO_4>PbBr_2>PbI_2.$$

It was also found that the addition of increasing amounts of the chloride, bromide, iodide or chromate of potassium to a definite amount of either $AgNO_3$ or $Pb(NO_3)_2$ did not affect the amounts of glycine or alanine required.

The clear solutions obtained were not colloidal. It is believed that chemical complexes are formed in solution. Further work on the elucidation of these is in progress.

23. On Langmuir's theory of adsorption.

A. GANGULI, Chandernagore.

Previously Langmuir's formula for adsorption and the value of Langmuir's constant were divided statistically [K. C. Kar and A. Ganguli, *Phys. z. 30*, 918 (1929), Ganguli, *J. Phys. Chem.*, *34*, 665 (1930)] and it was found that although the $k_{cal.}$ agreed with $K_{obs.}$ computed from results of Standard authors for ordinary temperature, discrepancies arose in some cases when the temperature was very low. In the present paper, the methods are modified by taking into consideration that the adsorbed molecule may occupy 'n' adsorption centres and Freundlich's adsorption isotherm is deduced as a first approximation. The Langmuir's constant

$$k=\left\{\frac{(2\pi mkT)^{\frac{1}{2}}}{\zeta}e^{-\frac{\alpha}{kT}}\right\}^{\frac{1}{n}}$$

where ζ=nh and α is adsorption potential. Again by following Stern's method it is found that the number of adsorbed molecules

$$N_a=\frac{N_0}{nN}\frac{\left\{\frac{p}{(2\pi mkT)^{\frac{3}{2}}}\cdot\frac{h^3}{kT}e^{\frac{\chi}{kT}}\right\}^{\frac{1}{n}}}{1+\left\{\frac{p}{(2\pi mkT)^{\frac{3}{2}}}\cdot\frac{h^3}{kT}e^{\frac{\chi}{kT}}\right\}^{\frac{1}{n}}}$$

where N_0 is the total number of adsorption centres, and 'n' is the number of the centres occupied by an adsorbed molecule and χ is identified with α. Consequently the expression for ionic adsorption (Kar and Ganguli, *Z. f. Phys.*, *61*, 411, 1930) is modified and we obtain for monovalent ions

$$a=\alpha c^{\frac{1}{n}}\left(e^{\frac{EF}{RT}}-e^{-\frac{EF}{RT}}\right)$$

where the constant α is the reciprocal of the Langmuir's constant 'k'.

24. Theories of periodic precipitation.

A. C. CHATTERJI.

Recently attempts have been made to revive the Ostwald's Supersaturation theory of periodic precipitation. As emphasised in previous papers, the one necessary condition of this theory is that the sparingly soluble salts should be capable of forming supersaturated solutions easily.

In this paper, the quantity of the various salts that can remain suspended in a gel has been determined. A few of the results obtained are given below.

No.	Salt.	Medium.	Suspended amount.	Ratio (*Quantity suspended*: solubility in water).
1.	Silver chromate	.. 2·3% gelatine	$4{\cdot}6 \times 10^{-3}$ N	26·6
2.	Silver chloride	.. 3·0% gelatine	$7{\cdot}61 \times 10^{-3}$ N	539·0
3.	Lead chromate	.. 3·0% gelatine	$2{\cdot}93 \times 10^{-2}$ N	$3{\cdot}95 \times 10^{5}$
4.	Lead chromate	.. 1·7% Agar	$7{\cdot}6 \times 10^{-3}$ N	$1{\cdot}02 \times 10^{5}$
5.	Mn. sulphide	.. 2·0% Agar	$3{\cdot}432 \times 10^{-2}$ N	$3{\cdot}432 \times 10^{5}$
6.	Silver sulphide	.. 3·0% gelatine	$4{\cdot}44 \times 10^{-3}$ N	$1{\cdot}037 \times 10^{14}$

From the above table it is apparent that very large quantities of these sparingly soluble salts can remain suspended in the gel when compared to their normal solubilities.

In a series of preliminary experiments conducted in this laboratory by M. R. Nayar, it was not possible to produce supersaturation with ammonium oxalate, potassium nitrate and sodium nitrate beyond 1·25 times their normal solubility. Similiar results are obtained by Tammann (*Zeit Anorg. Chem.*, 1931, *200*, 57) with nickel sulphate, potassium iodide, etc.

Moreover it has been our experience that it is difficult to produce supersaturation with salts that do not show a rapid increase in solubility with rise of temperature. Hence it is rather difficult to accept the view that such large quantities of so sparingly soluble salts can remain in supersaturated condition when more easily soluble salts cannot be made to go into supersaturation beyond 1·5 times the normal solubility.

The influence of gels on the solubility of salts is under examination.

25. Studies in the viscosity variations due to chemical reactions in liquid medii.

S. S. JOSHI *and* SUSARALA RAJU, Benares.

This has been investigated in the hydrolysis of methyl acetate, ethyl acetate, sucrose, maltose, lactose, acetic anhydride, and during the mutarotation of glucose and fructose under a wide range of conditions as to temperature and concentration. The results obtained show that the viscosity change can be utilised with much convenience and considerable precision to follow the progress of specially monomolecular reactions produced in liquid medii. Thus for instance in the hydrolysis of methyl acetate in the presence of 0·333 N and 1·6 N HCl values for the velocity coefficient calculated from the observed viscosity variation were $2{\cdot}44 \times 10^{-3}$ and $13{\cdot}2 \times 10^{-3}$ respectively. These compare well with the results of Lewis and Lamble (*J.C.S.*, 1914, **45**, 2330), who found the above constant under above conditions to be $2{\cdot}33 \times 10^{-3}$ and $13{\cdot}68 \times 10^{-3}$ respectively. A similar agreement is obtained for the values of the temperature coefficient of the velocity constant for the above change when determined by the present and the usual chemical method. An interesting case was observed in the hydrolysis of the bioses and in the mutarotation of the monoses mentioned above. This did not show any sensible variation of viscosity during the progress of the change for which an explanation has been suggested. Work also is in progress to examine the limits of the applicability of this method to other reactions both in liquid and gaseous medii.

26. Photochemical changes in rubber solutions.

R. K. VALVEKAR *and* S. K. KULKARNI JATKAR, Bangalore.

Solutions of purified pale yellow crepe rubber in benzene, chloroform, carbon disulphide and cyclohexanol were exposed to diffused daylight and light from a mercury arc in glass and quartz test tubes with control tubes. The viscosities of exposed solutions decreased more rapidly in

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quartz than glass tubes and fell nearly to that of the solvent and the solution lost all its adhesive properties after 12 hours exposure to the arc. Experiments are on hand to investigate the nature of change.

27. Condition of sparingly soluble substances when formed in presence of a gel:—Silver Chromate in gelatine from E.M.F. measurements. V.

A. C. CHATTERJI.

Nabar and Desai (*Nature*, April 25, 1931, page 628) from contact potential measurements have come to the conclusion that 95 per cent. of the silver chromate remains in the ionic condition.

From electric conductivity and diffusion experiments (*Trans. Faraday Soc.*, 1926. **72**. 23) we have proved that silver chromate remains in the colloidal state like other sparingly soluble salts.

In this paper E.M.F. measurements of cells of the following type were taken to find out the condition of silver chromate in gelatine.

Ag	N/10 Silver nitrate	saturated ammonium nitrate	Silver nitrate, Pot chromate in gelatine	Ag

The concentrations of silver chromate, which was formed by the addition of equivalent quantities of silver nitrate and pots. chromate, as well as of gelatine were varied within wide limits.

The results obtained indicate that in the case of silver chromate about 20–40% of the salt is in the ionic state. These results are in agreement with our former conclusion but they do not agree with the conclusion of Desai and Nabar.

Moreover, no decrease in the E.M.F. with time was observed with any of the mixtures, either yellow or red.

In our opinion, the action of gelatine on silver chromate is not different from its action on other sparingly soluble salts as suggested by Desai.

28. Effect of the addition of gelatine having different P_H values on the precipitation of silver chromate from aqueous mixtures of silver nitrate and potassium chromate.

B. M. NAIK, Bombay.

It is found that a slight increase in the acidity of gelatine increases its inhibitive power considerably and that the quantity of gelatine required to inhibit the precipitation of silver chromate increases with an increase in the concentration of either silver nitrate or potassium chromate.

The results tend to show that silver chromate exists in the ionic condition.

29. Variation of the charge of copper-ferrocyanide sol in the presence of electrolytes and non-electrolytes.

S. G. CHAUDHURY.

Copper ferrocyanide sols prepared by different methods show different cataphoretic speeds. The cataphoretic speed of the sol decreases by partial settling after centrifuging the sol. Also different forms of curves are obtained for the cataphoretic speed of the sol with KCl and $BaCl_2$ in presence of methyl alcohol and cane-sugar. The results have been explained on the basis of the adsorption theory.

30. Effect of washing and of electrolytes and non-electrolytes on the charge of barium sulphate.

JNANENDRANATH MUKHERJEE, NIRMALAPADA CHATTERJEE, *and* B. NARAYANADAS.

Barium sulphate was precipitated under different conditions and the endosmotic charge on the surface was measured in each case after continued washing.

The effect of different electrolytes such as KCl, HCl, H_2SO_4, K_2SO_4 and $BaCl_2$ and of non-electrolytes such as ethyl alcohol, methyl alcohol and cane sugar solution on the endosmotic charge of heavy spar (natural ore of $BaSO_4$) was observed. In presence of non-electrolytes the positive charge of the powder changed to negative in each case.

The observations are explained on the basis of strong adsorbability of $H^{\cdot}$ and OH' ions.

31. Coagulation and cataphoretic experiments on arsenious sulphide sol in its relation to the critical potential and influence of ionic environment of the sol on its cataphoretic speed.

JNANENDRANATH MUKHERJEE *and* S. G. RAJKUMAR.

Measurements of cataphoretic speed of arsenious sulphide sol with As_2O_3, KCl, HCl, NaCl, LiCl and $BaCl_2$ have been carried out up to the coagulating concentrations of these electrolytes. In the portion of the speed-concentration curve where the concentration is lower than ·01 N, the slope of the curves indicates that the adsorbability of the metallic ions is in the following order, Ba>Li>Na>K.

At higher concentrations however the slopes of the curves indicate that the adsorbability is in the order Ba>K>Na>Li. The curve for HCl cuts the other curves and indicates that its relative adsorbability changes with concentration even within this region.

32. The Mechanism of mutual coagulation.

D. C. BAHL, Lahore.

An attempt has been made to determine if there is any precipitation (1) when there is no possibility of chemical interaction between the stabilizing electrolytes, and (2) when the chemical interaction results in the formation of soluble salts and it has been shown that in mutual coagulation the neutralisation of the charge is not the only factor. Chemical interaction between the stabilising electrolytes (whenever they are present) plays an important part in mutual coagulation.

33. Change of viscosity and electrical conductivity of colloidal solutions on ageing.

D. N. CHAKRAVARTI, Amraoti.

With a view to distinguish between hydrophobe and hydrophile colloids the change of viscosity and electrical conductivity on ageing with respect to the following sols was studied :—

(1) Chromium hydroxide, (2) Ferric tungstate, (3) Mastic, (4) Antimonic acid, (5) Zirconium hydroxide, (6) Gum Dammar, (7) Chromium tungstate, and (8) Antimony sulphide.

It was observed that in the case of hydrophobe colloids the viscosity decreases and conductivity increases on ageing whereas for hydrophile colloids the opposite is true.

34. Colloid chemical analysis. Part II.

JNANENDRANATH MUKHERJEE, SATYAPRASAD ROY-CHOWDHURY, *and* AMIYAKUMAR SEN.

It is found in agreement with recent work that the addition of neutral electrolytes to ferric hydroxide and arsenious sulphide sols changes the P_H of the intermicellary liquid. The P_H regularly increases with the amount of the sol. Effect of different electrolytes in increasing the P_H of ferric hydroxide sol is in the order $K_2SO_4 > KNO_3 > KBr > KCl$. With arsenious sulphide sols KCl and KBr are found to have almost equal effects. With aluminium hydroxide sols it is found that with dilution the cataphoretic speed of the particles of the sol increases at the first dilution (1 : 1) and decreases on further dilution (1 : 5). Concentration of Cl′ ions, H° ion, and total chloride also decrease with dilution.

35. Stearic acid hydrosols—An electrometric study.

M. P. VENKATARAMA IYER.

Electrometric titrations of stearic acid hydrosols at different dilutions and at different intervals after mixing with sodium hydroxide solution, have been conducted. Similar experiments have also been repeated with barium hydroxide solution. The marked differences in the nature of the electrometric titration curves in the two cases has been explained from the standpoint of the interchange of ions taking place in the electrical double layer. The absence of a definite stoichiometric relationship between the total acid present, and the alkali required clearly supports the view put forward by Mukherjee that the process of neutralisation takes place by 'adsorption' at the interface. This work is being extended to the 'Colloidal' acids present in the soil.

36. Intermicellary composition and stability of ferrocyanide sols.

NIRMALAPADA CHATTERJEE.

Uranyl ferrocyanide, ferric ferrocyanide, cupric ferrocyanide, zinc ferrocyanide, cadmium ferrocyanide and aluminium ferrocyanide sols were prepared in such a way that the intermicellary liquid contained very slight traces of foreign electrolytes. The effect of stabilising electrolytes, of dilution and of hydrogen ion concentration on the peptisation and cataphoretic charge of the above sols were studied. It was found that the charge has got no simple relationship with the phenomenon of coagulation.

37. The 'apparent' and 'true' adsorption functions: the study of adsorption of a few binary mixtures by silica gel.

K. S. GURURAJA DOSS, Bangalore.

The forms of the apparent and true adsorption functions are discussed with reference to the results got by some of the previous workers as well as some obtained by the author, working with pyridine-water and carbon tetrachloride-alcohol mixtures. The changes in concentration due to adsorption were measured by means of a Pulfrich refractometer.

38. Studies in the slow coagulation of colloids from the standpoint of Smoluchowski's theory. Part III.

S. S. JOSHI *and* GURUDAS R. PHANSALKER, Benares.

By employing a method of measuring the degree of coagulation developed previously (Joshi and Prabhu, *Journ. Ind. Chem. Soc.*, 1931, **8**, 10, 337) the progress of coagulation of the arsenious sulphide sol has been studied at different temperatures and colloid concentrations. Calculating the Smoluchowski's constant from the equation,

$$\beta = \frac{1}{t}\left[\sqrt{\frac{\nu_0}{\nu_1}} - 1\right]$$

where the various symbols have their usual significance, it was found that in several series of coagulations smooth regular curves were obtained when β was plotted against t, the coagulation time, showing a continuous diminution of β. As observed previously (*loc. cit.*) the influence of temperature on β was less than that deduced from the Smoluchowski's theory.

39. On the factors governing the formation and stability of colloidal solutions of sparingly soluble organic acids.

M. P. VENKATARAMA IYER *and* H. RAMASWAMY IYENGAR.

The formation of colloidal solutions of stearic, palmitic and oleic acids by mixing up with water, solutions of these acids in different organic solvents, and at different temperatures and dilutions has been studied quantitatively. The presence of a polar group in the solvent employed plays a very important part in determining the formation and stability of the colloidal solution. The results are discussed from the standpoint of the surface orientation theory of Langmuir and Harkins. Formation of colloidal solutions by adsorption of constituent ions is discussed and evidence has been adduced to show that the simple mechanism of the colloidal acid ionising partially at the surface and thus conferring stability (as put forward by previous workers) is untenable. Experiments go to show that the stability of the particles is, to a large extent, due to hydration.

40. Studies in some physical properties of gels.

N. A. YAJNIK, D. N. GOYLE, *and* SHIV LAL.

In the present investigation a systematic study of some of the important physical properties of gels—both of organic and inorganic substances—has been carried out with a view to arrive at some conclusions regarding the structure of these gels.

As a result of this study it has been found that the organic gels show entirely different properties from those of the inorganic gels. The organic gels are more elastic, poorer conductors of sound, more hydrated (or generally speaking more solvated) and more transparent as compared to the inorganic gels.

Further work on the x-ray examination is being carried out and it is hoped that the data taken together with the results of the study made so far will give a fairly good idea of the structure.

41. The refractive index of colloids.

S. S. JOSHI *and* G. R. GODBOLE, Benares.

During the course of some work by one of us (S. S. J.) to be published shortly, on the variation of the Tyndall beam of colloids during coagulation, the importance of μ, the refractive index of the system as by far the

most important variable in the above and allied phenomena was noted. It has been now found in the case of the arsenious sulphide sol that any alterations in the value for μ produced by variations in the temperature and the colloid concentration are but slight, viz., of the order of 1–4 in 1000. They are however exceedingly characteristic of the nature and of the stage of the change produced. It has been found in accordance with Paine-Freundlich equations that the time required to produce a given stage of coagulation, as determined by the refractive index of the system, is an exponential function of the coagulator concentration, over a limited though considerable range of the last quantity, and of the colloid concentration. No evidence was obtained which indicated the existence of 'autocatalysis' at any stage during coagulations of even fairly concentrated sols. Results are also given for the variation of the Smoluchowski's constant during coagulations produced under widely varied conditions of temperature, the sol, and the electrolyte concentration.

42. The viscosity of colloids during coagulation.

S. S. Joshi *and* K. S. Vishwanathan, Benares.

Arising out of an investigation on the viscosity as a measure of the degree of coagulation produced in a colloid, it has been observed that in a number of coagulation-time curves the viscosity diminishes to a minimum during the initial stages of the change, and then increases steadily. The possibility of whether there occurs a preferential adsorption of ions of like charge by the colloid particles during the initial stages has been examined.

43. Organosols of sulphur.

B. S. Rao, Bangalore.

Sulphur sols in organic liquids [Garard and Colt, *J. Am. Chem. Soc.*, 49 : 630 (1927)] obtained by the interaction of hydrogen sulphide and sulphur dioxide owe their stability to persulphides of hydrogen whose presence in such solutions has been proved by a new test capable of detecting minute quantities of the persulphides. The inability of certain organic liquids (e.g., alcohol and glycerol) to form sulphur sols by the above reaction is shown to be due to the instability of hydrogen persulphides in such liquids.

44. Solubility of hydrosol sulphur in benzene.

M. R. Aswathnarayana Rao, Bangalore.

The coagulum got by the addition of sodium chloride to hydrosol sulphur (obtained by the action of hydrogen sulphide on sulphurous acid) was refluxed with benzene in Dean Stark's moisture determination apparatus and the effect of this treatment on the solubility at 25°C of the sulphur in benzene determined by a micro-chemical method. The benzene acquired a yellow colour and its sulphur content increased. This effect was probably due to the decomposition of the pentathionic acid present in hydrosol sulphur. Further treatment with fresh benzene gave a low value for the solubility. The hydrosol prepared with sulphurous acid in excess had a far higher solubility than the sol obtained when hydrogen sulphide was in excess.

45. Formation of jellies of hydrous alumina.

K. Subba Rao, Bangalore.

The effect of hydrogen ion conc. on the formation of jellies of hydrous alumina was studied by adding sodium aluminate solution and

an equivalent amount of hydrochloric acid simultaneously to Walpole's acetate buffer mixtures. Good jellies were obtained when the P_H was between 3·7 and 4·3. Below P_H 3·7 the jellies obtained were 'soft' and above P_H 4·3 the jellies were opaque [cf. Prakash and Dhar—*J. Indian Chem. Soc.*, 7 : 591 (1930)].

46. The adsorptive capacity of alumina gel.

K. SUBBA RAO, Bangalore.

The effect of temperature of activation on the adsorptive capacity of alumina gel was studied for the range 300° to 1100°C. The water content of the activated gel decreased with an increase in temperature but the capillary space in the gel as determined by the volume of carbon tetrachloride adsorped per gram of gel was maximum (0·3 c.c.) for the gel activated between 800°-850°C.

47. Adsorption by alumina gel.

K. SUBBA RAO *and* B. SANJIVA RAO, Bangalore.

Selective adsorption by alumina gel from binary mixtures of benzene with (*a*) ethyl alcohol and (*b*) carbon tetrachloride was studied. There is selective adsorption of ethyl alcohol over the entire range, but the 'S' shaped curve is obtained with carbon tetrachloride-benzene mixtures. Silica gel does not give the 'S' shaped curve with the latter. The significance of the difference in behaviour of the two gels is discussed.

48. Effect of the polyvalent stabilising ions on the autocatalytic nature of the coagulation of thorium hydroxide hydrosol.

N. V. KAREKAR *and* A. M. PATEL, Bombay.

The coagulation velocity of thorium hydroxide sol of different concentrations and dialysed to different extents when coagulated with potassium-, magnesium-, and aluminium-chloride solutions of different concentrations has been studied by a photo-electric cell method.

It is found that for the same concentration of the electrolytes, the coagulation velocity curves become more 'S' shaped with an increase in the valency of the stabilising ion.

49. Effect on the viscosities of thorium hydroxide hydrosol in presence of electrolytes.

N. V. KAREKAR *and* A. M. PATEL, Bombay.

The changes in the viscosities of thorium hydroxide hydrosol dialysed to different extents, on the addition of varying amounts of potassium chloride, magnesium chloride and aluminium chloride, have been studied.

It is found that with the progress of dialysis the viscosity of the sol increases.

It is also found that on the addition of increasing small amounts of electrolytes, the viscosity first increases and then decreases.

50. Effect of gases on the coagulation of thorium and ferric hydroxide hydrosols.

A. M. PATEL, Bombay.

The effect of coal gas, hydrogen, oxygen, carbon dioxide, nitrogen and acetylene, previously passed through water, when bubbled through thorium

and ferric hydroxide hydrosols containing varying amounts of electrolyte impurities has been studied.

It is observed that all the above gases were effective in bringing about the coagulation of the hydrosols. Carbon dioxide was found to be the best coagulant. It is also found that the amount of the gas required decreases with the increase in the purity of the colloids.

51. Sensitisation of thorium hydroxide hydrosol by non-electrolytes.

P. M. Barve, Bombay.

The coagulation velocity of thorium hydroxide hydrosol, dialysed to different extents, has been measured by a reliable optical method in presence of potassium chloride as well as magnesium chloride alone and also in presence of potassium chloride with non-electrolytes and of magnesium chloride with non-electrolytes.

It was found that with the progress of dialysis, i.e., with an increase in the purity of the sol, the sol is more and more sensitised by non-electrolytes, such as urea, propyl alcohol.

It is also observed that the sensitisation is less in case of magnesium chloride than in the case of potassium chloride when the sol is impure but with purer samples the difference is not well marked.

52. On the texture of commercial soaps.

P. C. Speers, N. A. Yajnik, D. N. Goyle, *and* Zafar-ud-Din Ahmad, Lahore.

Attempts have been made to investigate the applicability of the various methods to examine the texture of soaps. It has been found that the surface tension considerations play a very important part in determining the texture and appearance of soaps.

53. The saponification of emulsified oils.

P. C. Speers, N. A. Yajnik, D. N. Goyle, *and* Mohammad Shafi, Lahore.

Investigations carried out to enquire into the factors governing the saponification of emulsified oils showed that the following play an important rôle in the process of saponification :—

1. The magnitude of the oil-water interface or the degree of emulsification.
2. The total amount of the alkali present.
3. The amount of the oil-phase.
4. The amount of water.

Thus it has been found that the greater the magnitude of the oil-water interface or the degree of emulsification, the greater is the percentage of the oil saponified. The amount of the alkali in the system should be sufficient to saponify the oil present. A greater amount of the oil always lessens the degree of saponification. And lastly the presence of a very large amount of water is injurious to the process.

54. Petrol water emulsions.

B. N. Narayanaswamy, S. K. Kulkarni Jatkar, *and* H. E. Watson, Bangalore.

In continuation of previous work on the properties of petrol water emulsions prepared in the premier Colloid Mill, it was found that small quantities of air which were emulsified in the process profoundly modified

the physical properties, especially stability, so as to make the results non-reproducible. The mill was therefore modified to run continuously with one charge so as to trap as little air as possible and the resulting emulsions were found to be very reproducible in various properties such as viscosity, density and stability to temperature and suction. It was further found that both type of emulsions could be prepared beyond the inversion point which is about 32 per cent. petrol when using 5 per cent. of fresh ammonium oleate. The results are discussed from the numerous theoretical view points.

55. On the mechanism of unimolecular reactions.

A. GANGULI, Chandernagore.

In a previous paper [*Phil. Mag.* (1) *12*, 583, 1931] expressions for the velocity of unimolecular reactions have been deduced by considering that the molecules are first activated by absorption of radiation followed by the subsequent decomposition of the activated molecules by a mechanism similar to (*a*) thermal ionisation, (*b*) desorption. In the present paper the radiation theory as well as the collisional theory are discussed at length, and it is found that none of them is alone adequate enough to explain the observed facts. It is suggested that the energy required (critical increment) for bringing about a thermal unimolecular reaction is derived partly from radiation and partly from collision with surface atoms. The function of radiant energy is merely to loosen the valency electrons (corresponding to the resonance potential) and finally the disrupture brought about by collision. The values of 'k' were calculated from the formulæ derived for nearly all available unimolecular reactions and have been found to agree in a satisfactory manner with the experimental values of standard authors. A physical meaning of the effective collisional area (which, in most cases, is identified with the molecular cross-section) is also given. A mechanism of Raman Effect and also of photo-chemical reaction is suggested.

56. On the Raman Effect from the standpoint of unimolecular reactions.

A. GANGULI, Chandernagore.

Raman Effect is considered as unimolecular reaction according to the following scheme:

$$Am \xrightarrow{h\nu} A\alpha_1 \rightarrow An + h(\nu - \nu i) \qquad \text{(Stokes line)}$$

$$An \xrightarrow{h\nu} A\alpha_2 \rightarrow Am + h(\nu + \nu i) \qquad \text{(Antistokes line)}$$

where 'Am' and 'An' represent the molecules in the m^{th} and n^{th} states respectively. The molecule 'An' is regarded as a separate entity and the passage of a melecule from the $m \rightarrow n$ state is regarded as a chemical reaction involving the absorption of infra-red frequency νi. This is in accordance with the Radiation Theory of chemical reactions as postulated by Lewis and Perrin.

In order to calculate the number of molecules 'Nn' in the n^{th} state we follow a method due to Christiansen (*Z. Phys. Chem.* 103, 91, 1923) and thus obtain

$$N_n = N_m e^{-\frac{h\nu}{kT}} \frac{kT}{h} \quad \left(\text{for small values of } \frac{h\nu'}{kT}\right)$$

$$N_n = N_m e^{-\frac{h\nu}{kT}} \nu' \quad \left(\text{for large values of } \frac{h\nu'}{kT}\right)$$

Combining this with the radiation density we obtain

$$E_S = N_n\, \rho_{\nu'} = N_m \frac{k^2T^2}{h^e}\, \frac{8\pi\nu'^2}{c^3}\, e^{-\frac{h\nu}{kT}} \quad \text{(Raleigh-Jeans.)}$$

$$E_S = N_n\, \rho_{\nu'} = N_m \frac{8\pi h\nu'^4}{c^3}\, e^{-\frac{h\nu}{kT}}\, e^{-\frac{h\nu'}{kT}} \quad \text{(Wien.)}$$

Proceeding similarly for antistokes reaction we obtain

$$E_{AS} = N_m\, .\, e^{-\frac{h(\nu-\nu')}{kT}}\, e^{-\frac{h\nu}{kT}}\, \frac{8\pi\nu''^2}{c^3}\, \frac{k^2T^2}{h^e} \quad \text{(Raleigh Jeans)}$$

$$E_{AS} = N_m e^{-\frac{h(\nu-\nu')}{kT}}\, e^{-\frac{h\nu}{kT}}\, .\, \frac{8\pi h\nu''^4}{c^3}\, e^{-\frac{h\nu''}{kT}} \quad \text{(Wien.)}$$

remembering that 'Nn' is obtained by the absorption of $h\nu i$

Again since $\nu' = \nu - \nu i$ and $\nu'' = \nu + \nu_i$, we have

$$\frac{I_S}{I_{AS}} = \frac{E_S}{E_{AS}} = \frac{(\nu-\nu i)^2}{(\nu+\nu i)^2}\, e^{\frac{h\nu i}{kT}} \quad \text{(for high temp. or small value of } \nu i.)$$

$$\frac{I_S}{I_{AS}} = \frac{(\nu-\nu i)^4}{(\nu+\nu i)^4}\, e^{\frac{3h\nu i}{kT}} \quad \ldots\ldots \quad \text{(for low temp. or large value of } \nu i.)$$

Thus we see that the intensity is proportional to the square of the modified frequency in one case and to the fourth power in the other case.

This is in accordance with the results of Mandelstan and Landsberg, Orstein and others.

57. Kinetics of reactions between ions at great dilutions.

A. N. KAPPANNA *and* H. W. PATWARDHAN.

A study of the kinetics of the two reactions (1) sodium bromacetate + sodium hydroxide and (2) sodium bromacetate + sodium thiosulphate, has been made at 70°, 80°, and 90°C. in the region of ionic strengths 0·0005ω, 0·03ω. The salt effect in the first reaction is just the opposite of what is predicted by Brönsted's theory. In the second reaction the Brönsted-Debye theory has been found to quantitatively predict the course of reaction with variation in ionic strength.

58. Study of the decomposition velocity of napthol ethers when heated with halogen acids.

G. B. KOLHATKAR *and* V. V. BAPAT, Poona.

Concentrated hydrochloric or hydrobromic acid was added to a solution of the ethers in acetic acid and the mixtures then heated on a boiling water bath. The decomposition velocity was ascertained by estimating the napthols, liberated in the reaction mixture, after a definite interval of time.

The concentration of the halogen acids being about seventeen times that of the ethers, the velocity constants are determined on the assumption that the reactions are unimolecular. The values of the velocity constants obtained are tolerably constant and thus justify the above assumption.

A comparison of the velocity constants reveals the following relations :—

(1) The decomposition velocity with hydrobromic acid is 1·6 to 1·7 times greater than that with hydrochloric acid.
(2) The ethers of beta napthol decompose about 1·8 to 2 times as fast as those of alpha napthol.
(3) The decomposition velocities of ethyl and methyl ethers do not show much difference.

59. Influence of magnetic field on chemical reactions.

S. S. Bhatnagar, R. N. Mathur, *and* Ved Prakash.

The influence of a magnetic field on the deposit of copper on iron, when the latter is dipped in a solution of copper sulphate, has been studied. It is found that the amount of deposit in a magnetic field is always greater than that outside it varying with the concentration of the $CuSO_4$ solution, and the magnitude of the field. With initially magnetised iron pieces it is however found that the deposit on them is less than on the unmagnetised ones. Similar experiments have been performed on the deposition of silver from a solution ot $AgNO_3$, on iron and copper pieces. The results are expected to throw considerable light on the mechanism of this deposition.

60. Transportation of metals by electric arc stream.

Jitendra Nath Rakshit.

Electric arcs were produced between pairs of iron and pairs of copper electrodes, and transportation of elements by arc stream were determined per electrochemical equivalent of oxygen liberated by electrolysis, in series with the same circuit, of dilute sulphuric acid.

61. Oxidation-reduction potential of a few sulphydril bodies.

J. C. Ghosh *and* S. C. Ganguli.

The discovery of glutathione by Hopkins and the probability of this substance acting as a carrier of oxygen in the living tissues have created considerable interest in the determination of oxidation-reduction potential of sulphydril bodies. For cystin-cysteine oxidation reduction, Dixon and Michaelis find that a reversible potential is not attained. The authors find however that if cystine is reduced under anaerobic conditions at a mercury cathode, and the steady potential at the mercury cathode is measured some time after the electrolysing current is cut off, a thermodynamically reversible system is formed between P_H 6·6 to P_H 9. The E.M.F. is given by the equation

$$E = \cdot 0793 - \frac{RT}{F} P_H - \frac{RT}{F} \log \frac{[\text{cysteine}]}{\sqrt{(\text{cysteine})}}$$

62. Determination of the activity of peroxidases by the measurement of oxidation potentials.

B. B. Dey *and* M. V. Sitharaman, Madras.

It has been shown that the estimation of quinhydrone, formed by the oxidation of hydroquinone, provides a good method of determining the strengths of some of these plant oxidases. It is now found that the change in the concentration of hydroquinone, during its oxidation to quinhydrone by the enzyme, can be accurately followed by measurements of the oxidation potentials of the reversible system quinone: hydro-

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quinone, the concentration of the reductant (hydroquinone) varying continuously. A similar observation appears to have been recorded by Stearn and Day (*J. Biol. Chem.*, 1929, 85, 299) who noticed that quinhydrone itself—i.e., the hydroquinone component of it—was oxidised by potato oxidase, there being a rise in potential during the change. A method is now elaborated by which the activities of the enzymes may be studied by noting the changes in potential of the system peroxidase + hydroquinone + gaseous oxygen or H_2O_2 : quinhydrone, at constant low temperature.

63. Optimal P_H for the activity of peroxidase in Luffa Acutangula.

B. B. DEY *and* M. V. SITHARAMAN, Madras.

One of the interesting results of the experiments now in progress in this laboratory on the oxidising enzymes of plants is the observation that the peroxidase of Luffa Acutangula has its maximum activity only in a medium having P_H =6·5 and this is found to be precisely the value for the P_H of the normal sap itself. Electrometric measurements of the P_H of saps of a large number of different samples of the fruit, carried out at a temperature of 15°C., have shown that this value remains constant. The P_H of the medium has been varied from 3·6 to 7·0 by using buffers (*a*) succinic acid and borax, and (*b*) potassoum dihydrogen phosphate and borax, each buffer mixture being nearly saturated with hydroquinone (1·2 gram hydroquinone per 30 c.c.), and the experiment carried out by mixing 5 c.c. of this mixture with 5 c.c. of the fresh sap, 2·5 c.c. of 2% H_2O_2 solution, and 1 c.c. water, allowing the reaction to proceed at 15°C. for 25 minutes, stopping the reaction by adding 1·5 c.c. of N°HCl, and then estimating the precipitated quinhydrone iodimetrically (cf. *J.I.C.S.*, 1931, 479). The quinhydrone is found to increase steadily from P_H 3·6 to P_H 6·5, after which it falls rapidly.

64. Interaction of polybasic acids and neutral electrolytes. Part II.—Tartaric acid.

SUBODHKUMAR MAJUMDAR.

The change in the activity of hydrogen ions of solutions of tartaric acid in presence of different neutral electrolytes like LiCl, NaCl and $BaCl_2$ has been followed electrometrically and the thermodynamic dissociation constants calculated. As in the case of phosphoric acid (Part I, *J. Ind. Chem. Soc.*, 1931, *8*, 87) the results have been discussed in relation to the Debye theory and factors other than purely electrostatic ones.

65. Effect of electrodeless discharge on dye mixtures.

S. S. BHATNAGAR *and* S. D. MAHANT.

Alizarine and indigo mixed with $KClO_3$ do not show any change under the influence of the electrodeless discharge.

Methylene blue and zinc oxide quickly undergo decolorisation under the influence of the discharge, while chlorophyl and zinc oxide paste does not show any change.

Methylene blue and $CaCO_3$ show a distinct decolorisation under the action of the discharge.

Methylene blue is unacted upon by the discharge in the presence of mercury vapour.

66. Effect of electrodeless discharge on dyes.

S. S. Bhatnagar *and* S. D. Mahant.

Erythrosine, acriflavine, malachite green, alizarine, indigo, chlorophyl, fluorescein, eosine and methylene blue are not affected by exposure to the electrodeless discharge.

Chlorazol Fast, Eosin B (B. D. C.), Chlorazol Fast yellow B. N. Conc. (B. D. C.), Pinachrom, Pinacyanol, Pinaverdol, ethyl cyanine and rhodamin all show a distinctly darker shade after exposure.

67. Effect of electrodeless discharge on organic compounds.

S. S. Bhatnagar *and* S. D. Mahant.

Cinnamic acid on exposure to the electrodeless discharge in an atmosphere of oxygen gives a complicated product containing a CO group; this is quite distinct from the ordinary product of oxidation, benzaldehyde.

Resorcinol is unacted upon in the discharge; a mixture of resorcinol and phthalic anhydride exhibits a faint fluorescence after exposure; and a mixture of these two with zinc chloride quickly turns red, showing the formation of fluorescein.

Benzoyl peroxide is not affected by the electrodeless discharge.

68. The mechanism of photosynthesis of proteins in plants.

K. S. Varadachar, Bangalore.

A preliminary study (Varadachar, *Proceedings of the Indian Science Congress*, 1931) on sunflower plants (*Helianthus annus Linn*) starved of nitrogen in the soil and injected through the stem with 2 per cent. potassium nitrate solution showed the following characteristics :—

(1) The plants respond healthily to this treatment.
(2) There is an increase in Total N.
(3) There is no definite increase in the amide N and ammonia N.
(4) The diamino N increases in value.
(5) The nonbasic N decreases in value.
(6) There is no accumulation of nitrate.

The present investigation is a more detailed study of the same problem. A comparative study of the effect on protein synthesis of (1) intense respiration and photosynthesis by keeping the plants continuously in bright artificial light, (2) inhibited respiration and photosynthesis by keeping the plants in darkness, and (3) normal conditions of the fields has been followed in the present study.

Analytical data on the plant samples and conclusions drawn therefrom are outlined.

69. The photo-chemical reduction of aqueous solutions of silver salts of organic acids.

H. G. Dayal, J. M. Dhar, *and* P. S. MacMahon, Lucknow.

The aqueous solutions of certain silver salts of organic acids were exposed to strong sunlight and the silver reduction-products examined. The salts were found to vary greatly in their behaviour.

Some salts give complex silver sols while others are reduced directly to Ag—Ag_2O and no sol is formed. Some of the salts on reduction undergo different colour changes, showing progressive alteration in the complexity of the sols. Of the salts so far investigated the sols derived from the tartrate and malate are positively charged, whereas some of the others

as citrate and oxalate, in common with the sol produced from Ag_2O itself on photo-chemical reduction, are negatively charged.

The acetate, malonate, succinate give no sols.

These remarkable diversions are at present under examination, and the nature of the different sols under investigation.

70. The effect of ultra-violet light on the ferrous salts of aliphatic organic acids.

P. Lal *and* P. B. Ganguly, Patna.

The coagulation by light of Carey Lea's silver sol was explained by us on the basis of a photo-chemical change of ferrous citrate, the stabiliser for this colloid. A further study of the ferrous salts of hydroxy acids has shown that they are generally decomposed on exposure to light. Weighed quantities of pure iron were dissolved in varying quantities of tartaric, citric, malonic, malic, and mucic acids out of contact with air. On exposure, solutions of ferrous citrate and tartarate showed a distinct phototropy. The oxidation-reduction potentials as well as the P_H values of the solutions were measured before and after exposure. The quantities of ferrous and ferric iron, at different stages of the reaction, were determined by titration with titanium chloride. The P_H values were found to vary over a fairly wide range. It has been inferred that the iron not only replaces the H in the carboxyl group but also attacks the hydroxyl group.

71. Ignition of oxy-hydrogen gas mixtures in soap bubbles.

Harendranath Chatterji, Anathnath Mitra, *and* H. K. Sen, Calcutta.

In continuation of our previous work on the ignition points of explosive mixtures of gases (*J. Ind. Chem. Soc.*, 1929), it has been found that with the increase in the volume of the soap bubbles, the ignition temperature steadily diminishes, till after 350 c.c., it remains constant. A slight but perceptible retardation in ignition, however, is noticed. This may be due to the initiation of local catalytic surface combustion leading ultimately to explosion. It may thus be regarded as an example of Hinshelwood's chain reaction. The 1 : 1 mixture, with the particular platinum point used, ignites at 245°C., whilst 1 : 2 (O_2 : H_2) mixture ignites at 273°C. Evidences of the formation of hydrogen peroxide and ozone are noticed in most cases. With the variation in the lengths of the platinum wire, whether in the shape of a point source or in the shape of a spiral source, there is variation in the ignition temperature, the most distinctive feature being that with a spiral source the 1 : 2 mixture has the minium ignition temperature whilst the point source gives the minium ignition temperature with a 1 : 1 mixture.

72. Synthesis of methane from carbon monoxide and hydrogen in presence of spent sewage.

H. K. Sen *and* Manindranath Mazumdar, Calcutta.

Since the publication of Leiske's work on the conversion of carbon monoxide and hydrogen into methane in the presence of specific bacteria the possibilities of reducing the percentage of carbon monoxide in industrial gases is being explored. A spent sewage which showed no change in the manometer in a closed system for three days was treated with a mixture of one volume of carbon monoxide and three volumes of hydrogen under atmospheric pressure. After four days the mercury thread in the manometer began to rise, whilst after three weeks the rise was 38 cm. The ordinary equation—$CO+3H_2=CH_4+H_2O$ would require a contrac-

tion of three-quarters of the total volume. Under the experimental condition, therefore, a conversion of 66 per cent. into methane has been effected. Further experiments are in progress.

73. Synthesis of paraffins from carbon monoxide and hydrogen mixtures.

HARENDRANATH CHATTERJI *and* H. K. SEN, Calcutta.

By using an iron-copper-alkali catalyst and a 1 : 4 mixture of CO and H_2, solid and semi-solid hydrocarbons have been synthesised, using a temperature of 240°C. The exit gas shows the presence of gaseous hydrocarbons to the extent of 6 to 8 per cent. expressed in terms of methane and 8 to 10 per cent. CO_2. It is therefore usable under boilers. Technical possibilities are discussed.

74. Simultaneous oxidation and dehydration by thoria as catalyst.

B. C. ROY, Calcutta.

In continuation of the work in connection with the preparation of ethyl-aniline, by passing the vapours of ethyl alcohol and aniline over heated thoria, an experiment was conducted by passing air along with the two vapours. After distilling off the ethyl aniline, the tarry residue was extracted with boiling water and on cooling a crystalline substance was deposited. On purifying by recrystallisation from hot water, the substance was found to be acetanilide. The formation of this can be explained by assuming that a part of the ethyl alcohol was oxidised to acetic acid, which by dehydration with aniline produced the acetanilide.

Further experiments regarding the behaviour of thoria as a simultaneous oxidising and dehydrating catalyst is in progress.

75. Interaction between carbondioxide and sulphuretted hydrogen.

M. GOSWAMI *and* B. C. ROY, Calcutta.

When passed over thoria at 300° a mixture of CO_2 and H_2S gave methane and sulphur presumably according to the reaction $CO_2 + 4H_2S = CH_4 + 2H_2O + 4S$; systematic study of this has been done.

76. A method for the purification of coal gas.

M. GOSWAMI, B. C. ROY, *and* H. N. DAS GUPTA, Calcutta.

The reaction $2NO + 5H_2S = 2NH_3 + 2H_2O + 5S$ has been taken advantage of, in purifying coal gas containing definite amount of H_2S. The aim of the work is to technically utilise the reaction in the purification of coal gas in gas works.

77. Reaction between hydrogen sulphide and sulphur dioxide in non-aqueous solutions.

B. S. RAO *and* M. R. A. RAO, Bangalore.

Thio-sulphonic acid (thio-sulphurous acid) has been suggested by the authors as the primary product of the reaction between hydrogen sulphide and sulphur dioxide in non-aqueous solutions (*Nature*, 128: 413, 1931). The solutions have been found to contain persulphides of hydrogen. It is suggested that the persulphides are produced by a reversible reaction between thio-sulphonic acid and hydrogen sulphide.

Klein (*J. Phys. Chem.*, 15, 1, 1911) could obtain no correlation

between any physical or chemical property of a liquid and its ability to induce chemical reaction between the two gases. The authors find that the latter property can be correlated with the ability of the liquid to decompose hydrogen persulphide.

78. The reaction between sodium sulphite and sulphur.

S. G. KIRI, K. R. KRISHNASWAMI, *and* H. E. WATSON, Bangalore.

A continuation of the work of Watson and Rajagopalan (*J. Indian Inst. Sc.*, 1925, *VIIIA*, 275).

The reaction was studied employing preparations of sulphur of roughly uniform size, e.g., 60–80 and 100–120 mesh. Comparative estimates of the specific surfaces of the different samples were also obtained by colorimetric measurements of adsorption of Bismark Brown. Although the rate of reaction was found to increase with the surface of the sulphur particles, no quantitative relationship between the two could be established.

79. Alcoholysis of cocoanut oil.

M. GOSWAMI *and* JAGADANANDA DUTT, Calcutta.

In continuation to the work on alcoholysis published in (*J.I.C.S.*, 1931, Vol. 8, P. 413) by Goswami and Ramanujam the following catalysts have been tried:—Phenol-sulphonic acid, Arsenic acid, Phosphoric acid and Glycerophosphoric acid.

80. The formation and dissociation of polyhalides of hydrogen in aqueous solution. 1. Hydrogen chlorobromide.

S. K. ROY, Calcutta.

(Communicated by P. Rây.)

The formation of hydrogen chlorobromide has been studied from the depression of the freezing point of aqueous solutions of hydrochloric acids by the addition of bromine. The equilibrium constant and the heat of reaction have been calculated from the results obtained. (cf. Rây and Sarker, *J.C.S.*, 1922, 1449).

81. Action of nitric acid on tin.

G. S. KASBEKAR, Bombay.

The action of Nitric acid on Tin has been studied,

(*a*) by varying the concentration of acid,
(*b*) by varying the amount of tin,
(*c*) by varying the physical condition of tin,
(*d*) by varying the temperature,
(*e*) in presence of various catalysts,

in an atmosphere of carbon dioxide. The amount of tin present in the stannous form was determined by iodine titration.

It is found that,

(1) the amount of stannous salt formed first increases with increase in acid concentration up to a limit and then decreases;
(2) increasing the temperature decreases the yield of the stannous salt;
(3) percentage of the stannous salt formed from tin-foil is higher than from granulated tin;
(4) some catalysts are observed to have a marked effect on the yield of the stannous salt.

82. Period of induction in chemical reactions. Part III—Interaction of potassium bromate and hypophosphorous acid.

P. Neogi *and* B. N. Sen.

The period of induction has been fully studied with respect to the influences of concentration, temperature, and foreign substances, viz., electrolytes, non-electrolytes and colloids added to the reacting system. The induction period varies inversely as the concentration of each and both of the reactants. The temperature-induction-period curve shows a straight line, the period diminishing with the rise of the temperature. Non-electrolytes like alcohols diminish the period but to different extents, whilst the solvents of bromine cause a more marked diminution in the period with exception of benzene which causes an increase. The colloids and thiosalts considerably diminished the period.

83. Period of induction in chemical reactions. Part IV—Interaction of sodium iodate and phosphorous acid.

P. Neogi *and* Sudhamoy Mukherjee.

The relations between concentration and the induction period and between temperature and induction period are similar to those obtained in the previous investigation. The alcohols reduced the period considerably and in the case of the two isomeric propyl alcohols the periods are so widely divergent that the reaction may well be used as a test to differentiate the two alcohols. Solvents of iodine markedly reduced the period. Inorganic acids also have considerable influence in causing a diminution in the period.

84. Period of induction in chemical reactions. Part V—Interaction of sodium bromate and phosphorous acid.

P. Neogi *and* Sudhamoy Mukherjee.

Similar results have been obtained in the course of study of the period of induction in the interaction of sodium bromate and phosphorous acid.

85. On isomeric borohydrates.

R. C. Ray, Patna.

The potassium salt of a borohydrate of the composition $B_2H_4(OH)_2$ has been described in a previous paper (*Jour. Chem. Soc.*, 1922, *121*, 1088–94). Two isomeric compounds of the same composition, $B_2H_4(OK)_2$, have been obtained. One is formed by the action of water on magnesium boride, and the other by the action of water on magnesium boride which has previously been mixed with 10 per cent. free boric acid. Hydrogen is evolved from both the isomers when their solutions are acidified with dilute hydrochloric acid, and if the acidified solutions are then treated with standard iodine solutions, a certain amount of iodine is removed in both cases. The ratio of H/I is, however, in one case 2 : 1 and in the other 1 : 2. It has not yet been possible to assign constitutional formulæ to the isomeric compounds.

86. On certain monofluophosphates.

H. C. Goswami *and* Pulinbihari Sarkar, Calcutta.

Prof. Willy Lange and the authors have simultaneously discovered the monofluophosphates. The authors first showed the isomorphism of mono-

fluophosphates with sulphates. The preparation and properties of the following simple monofluophosphates have been studied, viz: the heptahydrated nickel and cobalt salt—the pentahydrated copper and zinc salt, analogous to the corresponding sulfates. The following double monofluophosphates analogous to the corresponding double sulphates have been prepared, viz., ammonium with nickel and ammonium with cobalt.

The alums corresponding to the sulphate alums were prepared and complete series of mixed crystals with sulphates have been effected.

87. Fluoberyllates and their analogy with sulphates. Part II—Fluoberyllates of certain bivalent metals.

NIRMALENDUNATH RÂY, Calcutta.

(Communicated by P. Rây.)

In part I of this investigation it was shown that the fluoberyllate ion ($BeF4''$) exhibits a very close analogy with the sulphate ion (SO_4''). The analogy has been found to be most perfect with respect to the solid salts. In the present paper the preparation and properties of the fluoberyllates of some bivalent metals have been described. The salts studied are:

Calcium and strontium fluoberyllates (anhydrous) and nickel, cobalt, zinc, ferrous and copper fluoberyllates (hydrated).

These fluoberyllates resemble the corresponding sulphates not only in their chemical composition but also in their crystalline form, molecular volume, solubility, etc. Fluoberyllates soluble in water have been found to form mixed crystals with the corresponding sulphates.

88. Fluoberyllates and their analogy with sulphates. Part III—The Double fluoberyllates.

NIRMALENDUNATH RÂY, Calcutta.

(Communicated by P. Rây.)

Further corroborative evidence of the existence of analogy between the sulphate and the fluoberyllate ion has been furnished by the preparation of a number of double fluoberyllates which resemble the well-known double sulphates of the type $M'_2\, SO_4,\ M''\, SO_4,\ 6H_20$ not only in chemical composition but also in other properties such as crystalline form, molecular volume, solubility, etc. The following double salts have been described:

Hexa hydrated double-sulphato-fluoberyllates of nickel-potassium and zinc-ammonium and hexa-hydrated double fluoberyllates of ammonium fluoberyllate with those of nickel, cobalt, zinc, manganese, cadmium, copper and iron.

These double salts form mixed crystals with the corresponding double sulphates.

89. Fluoberyllates and their analogy with sulphates. Part IV—The ammino-fluoberyllates.

NIRMALENDUNATH RÂY, Calcutta.

(Communicated by P. Rây.)

By analogy with the amminosulphates, the ammino-fluoberyllates of silver, copper, zinc, cadmium, nickel and cobalt have been prepared and studied.

90. On the complex cyanides of rhenium.

H. C. GOSWAMI *and* PULINBIHARI SARKAR, Calcutta.

In all its stable salts rhenium is heptavalent. The lower valency rhenium is very unstable. Tetravalent rhenium has been stabilised by forming complex cyanides.

91. Some new tetrammine cobaltic complexes and a study of their constitution by means of absorption spectra.

T. DAS GUPTA *and* PULINBIHARI SARKAR, Calcutta.

The reaction of sodium thiosulphate with cis-diaquo-or transdichloro-tetrammine cobaltic salts has been carefully studied resulting in the isolation of a new series of thiosulphato-aquo-tetrammine cobaltic complexes. Some co-ordination and ionic isomers have been studied. A new method of preparation of the triol-dicobaltic hexammine compounds has been worked out. The constitution of the tetrammine salts has been determined from a study of their absorption spectra.

92. Complex compounds of metallic sulphites and thiosulphates with ethylenediamine.

P. NEOGI *and* HAMID HOSSAIN.

Complex Compounds of thiosulphates and sulphites of cobalt, nickel, zinc, chromium, cadmium, and some other metals with ethylenediamine have been obtained and their constitution determined.

93. Complex compounds of metallic hypophosphites, nitrites and arsenites with ethylenediamine.

P. NEOGI *and* MOHINI NATH PHUKAN.

Complex compounds of metallic hypophosphites, nitrites and arsenites with ethylenediamine have been prepared and their constitution determined.

94. Salts of thiosulphato pentacyano cobaltic acid.

S. N. MAULICK, Calcutta.

(Communicated by P. Rây.)

Thiosulphato pentacyano cobaltic acid, and its alkali- and alkaline earth salts have already been described (Rây, *J. Indian Chem. Soc.*, 1927, *5*, 325: Rây and Maulick, *Zeit. anorg. Chem.*, 1931, *199*, 355). The present paper deals with the preparation of a number of metallic and metal-ammonium salts. Beryllium (basic), manganese, manganese-potassium, silver, silver-ammonium, di- and tetra-ammonium copper, di- and tetra-ammonium zinc, and di- and penta-ammonium nickel salts have been studied.

95. Compounds of hexamethylene tetramine with complex cobalt salts and the nature of residual affinity.

PRIYADARANJAN RÂY *and* MUNINDRA NATH BUXI, Calcutta.

A large number of molecular compounds of hexamethylene tetramine with various salts of thiosulphato pentacyano cobaltic acid have been prepared, and the number of water molecules contained in these molecular compounds are compared with those present in the original complex salts. The difference in hydration, observed in this case, as well as in many

other cases previously examined by other investigators, throws considerable light on the nature of residual affinity.

96. Substituted complex cyanides of cobalt and the influence of substitution on the properties of complex ions.

PRIYADARANJAN RÂY *and* S. K. CHACKRABARTY, Calcutta.

Metallic salts of an entirely new type of substituted complex cobaltic acid—disulphito tetracyano cobaltic acid—have been prepared, and the constitution of the complex anion is established by various physical and chemical methods. The mobility and the radius of this new complex ion as well as those of the thiosulphato pentacyano cobaltic ion have been determined. From a comparison of the ionic radii of the simple and complex ions of cobalt, some idea about the stability and the strength of the complex ions has been deduced.

97. The estimation of potassium by the cobaltinitrite method.

S. D. SUNAWALA *and* K. R. KRISHNASWAMI, Bangalore.

The method yields good results only when the relative concentrations of the reactants lie within narrow limits. The precipitates obtained under varying conditions were completely analysed, and the conditions suitable for obtaining $K_2Na\ Co\ (NO_2)_6 . H_2O$ in a pure state were studied. The data obtained enable the determination to be made with an accuracy of about 1 per cent.

98. Qinaldinic acid as an analytical reagent. Part I—Estimation of copper, cadmium and zinc, and the separation of copper from cadmium.

PRIYADARANJAN RÂY *and* M. K. BOSE, Calcutta.

Various metallic salts of quinaldinic acid have been prepared and their composition and properties studied with a view to determine their applicability for analytical purposes. Copper is completely precipitated in dilute mineral acid solution, whereas zinc and cadmium are quantitatively thrown down from dilute acetic acid and neutral solution respectively. The precipitate formed are highly crystalline and can be very rapidly filtered in a Gooch crucible. Copper, zinc and cadmium have been estimated with excellent results. A quite accurate, rapid and satisfactory method has been developed also for the quantitative separation of copper from cadmium.

99. Chemical examination of some vanadiferrous ilmenites of India.

NIRMALENDUNATH RÂY, Calcutta.

(Communicated by P. Rây.)

Vanadium was discovered a century ago in certain Taberg (Småland) iron ore. Certain ilmenites have been found to contain traces of vanadium. The author has recently examined a few specimens of Indian ilmenites which are characterised by their high percentage (5%) of vanadium. Complete chemical analysis has been done and its composition determined.

100. The chemical and spectrographical examination of some columbites of Gaya.

H. C. GOSWAMI *and* PULINBIHARI SARKAR, Calcutta.

The Gaya columbites are feebly radio active due to the small amounts of uranium and thorium present in them. A complete chemical analysis of the mineral has been made and a detailed accurate method has been worked out for the analysis of this type of minerals as the methods hitherto adopted are all faulty. Rhenium has been found and has been extracted from 3 kilos of the mineral.

101. The analysis of mixtures of the pentoxides of tantalum and niobium.

D. S. NARAYANA MURTHI, K. R. KRISHNASWAMI, *and* H. E. WATSON, Bangalore.

None of the methods in common use was found to be rapid or simple. The method outlined by Ruff (*Z. anorg. Chem.*, 1926, *156*, 215) but left undeveloped has been studied by us in detail and found to be entirely satisfactory.

The method is based on the observation that when heated in a stream of hydrogen, iobium pentoxide is quantitatively reduced to niobium tetroxide, whereas tantalum pentoxide remains unaffected.

102. Note on the filling of nanometers.

M. Q. DOJA.

An improved method for the filling of manometers has been devised. This gets over the difficulty of elaborate sealing which is necessary in the filling of the usual vacuum filled manometers. It also gives a much stronger sealed end than is possible to obtain in the other method, because the sealing is done before the mercury is introduced into the manometer. The method is simple and consists only in introducing pure dry mercury into the evacuated manometer by means of a suitable apparatus which has been described.

103. Action of hypochlorous and other acids on di-isobutylene.

M. L. SHROFF, Benares.

Di-isobutylene was prepared by condensing tertiary butyl alcohol by means of sulphuric acid. A study of the addition products of di-isobutylene with hypochlorous acid, chlorine monoxide, and sulphuric acid was made. Instead of a chlorhydrin, an unsaturated chloride of the empirical formula $C_8H_{15}Cl$ was obtained, Chlorine monoxide gave a complex mixture of chlorine compounds whereas with concentrated sulphuric acid higher polymers of di-isobutylene were obtained.

104. A preliminary note on the production of oxalic acid from sandal wood dust.

B. H. IYER, Bangalore.

Sandal dust obtained after the removal of the essential oil is being tried as raw material for the production of oxalic acid. The quantitative estimations carried out so far show that 45 per cent. (on the weight of sun-dried dust) of oxalic acid is formed by fusing the dust with alkali at 200° for two hours. The optimum conditions are being worked out and

the real isolable oxalic acid being estimated with a view to see if oxalic acid could thus be profitably produced.

This dust when extracted yielded to petrol 2·5 per cent. of a dark resinous substance which gave an alcohol-insoluble substance as also a bromo-derivative. All these products are under investigation.

105. The fatty acids of 'Ben' oil.

P. RAMASWAMI AYYAR *and* V. C. PAREKH, Bangalore.

These were separated and esterified by the usual methods and have been found to consist of Myristic (7·3 per cent.), Palmitic (4·2 per cent.), Oleic (65·8 per cent.), Stearic (10·8 per cent.), Behenic (8·9 per cent.), and Lignoceric (3·0 per cent.) acids. The Behenic acid has been proved to be the normal one by direct comparison with a specially synthesised specimen.

106. The fatty acids of Mysore 'Chrysalis' oil.

P. RAMASWAMI AYYAR *and* V. C. PAREKH, Bangalore.

These have been shown to consist of Palmitic (13·5 per cent.), Stearic (4·0 per cent.), Oleic (33·8 per cent.), Iso-linoleic (38·2 per cent.), and α-linolenic (10·5 per cent.), and an unidentified lower fatty acid.

107. Studies in the synthesis of higher fatty acids. Part V.

V. A. PATWARDHAN *and* P. RAMASWAMI AYYAR, Bangalore.

The action of sodium on 11-Bromo-undecylic methylic ester has been studied.

108. Studies in the synthesis of higher fatty acids. Part VI —The reactivity of higher alkyl iodides with magnesium.

P. RAMASWAMI AYYAR *and* V. C. PAREKH, Bangalore.

The yields of Grignard reagents from six alkyl iodides from $C_{12}H_{25}I$ to $C_{22}H_{45}I$ have been determined, and incidentally, two new hydrocarbons $C_{40}H_{82}$ (m.p. 79–81°) and $C_{44}H_{90}$ (m.p. 83–85°) have been synthesised.

109. Studies in fish oils. Part III—Study on the constitution of certain unsaturated fatty acids characteristic of fish oils.

K. D. GUHA, Bangalore.

A sample of Scottish cod-liver oil was used as a source of fatty acids. The acetone-lithium salt separation of the fatty acids and subsequent distillation of their methyl esters were used for the separation of individual acids. The position of double bonds in C_{16}, C_{18}, C_{20} and C_{22} acids with varying degree of unsaturation were studied.

110. Action of alkylene bases on esters.

M. N. RAMASWAMI *and* P. C. GUHA, Bangalore.

In connection with some other work being done in this laboratory we had occasion to try the action of ethylenediamine on acetoacetic ester. Mason (B. *20*, 267) considered the product of the reaction to be ethyl ethylene-di-β-amido-α-crotonate and claimed that he obtained the corres-

ponding free acid by heating either the crotonate with water or by heating acetoacetic ester in a sealed tube with ethylenediamine. We have been unable to confirm these results.

This leads us to suspect whether the product of the reaction was really what it was represented to be. The present paper embodies the results obtained by the action of alkylene bases on esters in general and experiments conducted to find the constitution of the resultant products.

111. Extension of Michael's reaction.—Part IV.

T. N. GHOSH *and* P. C. GUHA, Bangalore.

In the *Proceedings of the Eighteenth Indian Science Congress*, 1931, the condensation of phenylazocarboxylic ester, azodicarboxylic ester with the sodium derivatives of acetoacetic ester, etc., was reported. In continuation of the same work, carbethoxythiocarbimide COOEt—N=C=S has been found to react with the sodium derivatives of cyanacetic ester, and acetoacetic ester to yield the usual additive products. With malonic ester, however, a compound of the type

$$\text{COOEt—NH—CS—}\underset{\displaystyle\text{COOH}}{\underset{|}{\text{CH}}}\text{—COOEt}$$

has been obtained. Mesoxalic-ester-phenylhydrazone $(COOEt)_2=C=N-NHPh$, reacting with the sodium derivatives of acetoacetic ester, malonic ester, etc., is simply converted into COOEt—CH(COOH)—NH—NHPh. Evidently therefore the expected Michael's condensation has not taken place here, perhaps due to the presence of the positive group =N—NHPh.

112. Studies in the acetylation of ligno-cellulose.—Part II.

PABITRAKUMAR DAS *and* H. K. SEN, Calcutta.

The acetylation of cellulose or ligno-cellulose under pressure without the use of any catalyst does not appear to have been undertaken by previous workers. This process was considered to have a peculiar suitability in the determination of the relationship between lignin and cellulose in ligno-cellulose, that is to say whether the two are chemically combined or physically adsorbed. The central idea underlying this view is that if lignin and cellulose are chemically combined and if during acetylation under pressure acetolysis takes place and the lignin is set free from its combination with cellulose, then there should be a new centre for acetylation in addition to the already existing centre for mono-acetylation in the cellulose. A necessary inference from this would be that a modified cellulose, that is to say cellulose isolated from ligno-cellulose by Cross and Bevan's method or chlorine peroxide method or by cuprammonium method would yield under pressure even in the absence of catalysts a diacetylderivative. This expectation has been realised. There is however an evidence which weakens this theory. It is found in the acetylation of the standard cellulose, cotton itself. Under similar experimental conditions, treated or untreated cotton gave an acetyl value almost nearly agreeing with the monoacetyl. One would be disposed to explain this difference by considering that cotton is a more highly polymerised condition of cellulose. This view is supported by the lower alkali adsorption of cotton in comparison with cellulose from saw dust. To bring all the three under the same category and to explain the inequality in their capacity for undergoing acetylation, one is thus forced to think that this difference arises out of a difference in the degree of polymerisation and the theory that lignin is chemically combined with cellulose loses all force. But to accept that ligno-cellulose which is formed through such a long number of years in the plant world should represent a lower state of polymerisation than cotton is somewhat difficult.

Incidentally acetylation in the presence of sulphuryl chloride,

perchloric acid and limiting quantities of sulphuric acid have been investigated, leading to the establishment of the fact that it is the tri-acetyl derivative alone that gives optically clear solutions. The lower acetates yield only colloidal solutions depending on the size of the particles. The higher the acetylation, the greater the depolymerisation.

Viscosity experiments have been undertaken in this connection.

113. Studies on vegetable proteases. Part I—Protease from Cicer Arietinum and Vigna Catiang, Endl.

N. Desikachar *and* C. V. Paramasivan, Bangalore.

Two of the commoner Indian cereals *Cicer Arietinum* and *Vigna Catiang*, Endl. were germinated and the proteases extracted in the usual manner. The preparations were examined (1) for their hydrolysing action on proteins and (2) for their adsorption behaviour by various colloids.

A trial has also been made to aim at the separation of the two existing enzymes, viz., Ereptase and Protease, by adsorption methods.

114. On inulase.

N. Keshava Iyengar, Bangalore.

Inulase has been prepared from 'Aspergillus sp.?' by culturing the fungus on an aqueous extract of Artichoke which is found to contain 20 per cent. inulin of the total carbohydrates. After 4·5 days growth, the fungus mat was collected, washed and dessicated in vacuo over sulphuric acid. A grey powder is obtained on grinding the dried material from which an active preparation of the inulase extract is obtained by macerating a given weight of the dry powder with twenty-five times the quantity of toluenated water at room temperature for 24 hours. The filtrate yields an extract rich in inulase but associated with other carbohydrates like invertase and amylase. Various adsorbents are being tried in order to free the extract from other enzymes. A time course study of the inulase extract on inulin at 3.8 P_H has been completed.

115. On the synthesis of uric acid.

P. C. Guha *and* G. R. Gogte, Bangalore.

The present paper is a continuation of previous work (*Proc. Indian Sc. Congress*, 1930, 1931). The action of phenylcarbonate upon ethylene-, oxalo- and glycolyl-diurea as also upon hydantoin acid amide has been studied. The action of urea and biuret upon hydantoin ester $NH_2.CO\text{-}NH\text{-}CH_2\text{-}COOEt$ and of urea upon biuret acetamide $NH_2\text{-}CO\text{-}CH_2\text{-}NH\text{-}CO\text{-}NH\text{-}CO\text{-}NH_2$ is under investigation.

116. $\beta\beta'$ Diketo cyclobutanes.

V. M. Dixit, Poona.

Pechmann (*Ber.*, 1883, *16*, 2124 and Annalen, 1889, *261*, 167) heated citric acid with conc. sulphuric acid to prepare acetone dicarboxylic acid which he condensed with phenols to obtain coumarins. Instead of separating the acetone dicarboxylic acid, he mixed phenols directly with the reaction mixture and later workers have been using the same process for the preparation of the coumarin derivatives.

The author has, however, obtained $\beta\beta'$ diketo cyclobutane carboxylic acid $\begin{array}{l} CO\text{—}CH.CO_2H \\ | \qquad\quad | \\ CH_2\text{—}CO \text{ (A)} \end{array}$ (m.p. 144°, equivalent 128), (1) by the action of sulphuric acid on citric acid, and (2) by heating acetone dicarboxylic acid

at its m.pt. The new compound being susceptible of hydrolysis to acetone dicarboxylic acid, can only be preserved in sealed tubes.

The new compound gave both mono and di-phenyl-hydrazones, a monoacetyl derivative, a monobromo compound by substitution and a monochloro derivative. The last one gave $\beta\beta'$ dichloro cyclobutadiene with phosphorus pentachloride.

Elimination of CO_2 under reduced pressure from (A) gave a substance of the probable formula $\begin{array}{l} CO—CH_2 \\ | \quad\quad | \\ CH_2—CO \end{array}$ (B) which gives a hydrazone and is converted into $\beta\beta'$ dichloro cyclobutadiene by phosphorus pentachloride. A compound having the empirical formula of (B) has been obtained by Staudinger (*Ber.*, 1920, *53*, 1085).

The acid (A), on condensing with anisol, in sulphuric acid, gave a para substituted cyclobutenone carboxylic acid:—

$$\begin{array}{l} CH_3O \,.\, C_6H_4 \,.\, C = C \,.\, CO_2H \\ \qquad\qquad\quad\;\; | \qquad | \\ \qquad\qquad\quad\; CH_2—CO \end{array}$$

The work is being continued.

117. Formation and stability of a dicyclohexanone.

P. S. MAYURANATHAN *and* P. C. GUHA, Bangalore.

Condensation of isopropylidene malonic ester and acetoacetic ester was carried out and the constitution of the resulting addition product ($\alpha\alpha\gamma$-tricarboxy-$\beta\beta$-dimethyl-δ-keto-ethyl butyrate) and ring-closed product (cyclohexane-1 : 1-dimethyl-3 : 5-diketo-2 : 6-dicarboxylic ester) definitely established by conversion into Vorlander's dilactone and dimethyldihydro-resorcin respectively, which were in turn obtained from the addition and condensation products of mesityl-oxide and malonic ester.

On regulated hydrolysis of the ring-closed ester a *dicyclo*hexanone was obtained which presented a new and interesting study of bridge formation and double bonds, their formation and stability, in dimethyl-dihydro-resorcin. The product is a dehydrated compound of dimethyl-dihydro-resorcin and definitely establishes the presence of para bonds in phenols.

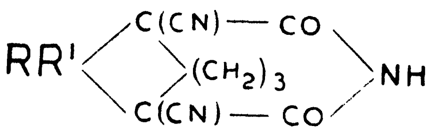
The reactivity and stability of the ring-closed ester towards methylene iodide in presence of sodium was also tried without success. Incidentally, the effect of the gemdialkyl and cyano-groups in the formation of *cyclo*butane acids was tried. Also the mobility of a tautomeric hydrogen in intermolecular-intramolecular tautomerism was investigated.

118. On spiro-compounds. Part II.

P. K. PAUL, Calcutta.

(Communicated by P. C. Mitter.)

With a view to see whether six-membered hydro-aromatic ring systems can associate with six-membered spiro rings, the Guareschi imides from cyclo-pentanone, cyclo-hexanone, 3-methyl cyclo-hexanone and 4-methyl cyclohexanone were condensed with trimethylene bromide following the line of C. A. Kerr (*J. Amer. Chem. Soc.*, 1929, *51*, 617) and condensation product of the following type has been obtained. RR' being part of different ring systems.



Cyclo-pentane spiro dicyan cyclo-hexane imide, crystallises from acetic acid—m.p. 258°C. Cyclo-hexane spiro dicyan cyclo-hexane imide crystallises from acetic acid—m.p. 204°C. 3-Methyl cyclo-hexane spiro dicyan cyclo-hexane imide, from dilute acetic acid—m.p. 202°C. 4-Methyl cyclohexane spiro dicyan cyclo-hexane imide crystallises from acetic acid—m.p. 212°C.

The work is being progressed.

119. Attempted synthesis of cantharic acid.

V. N. Pal *and* P. C. Guha, Bangalore.

Methyl-*cyclo*hexan-1 : 4-dione-2 : 3-dicarboxylate has been prepared by the reduction of the corresponding dihydroxyphthalic acid. Experiments are in progress to methylate this ester in the 2, 3 positions, and the dimethyl derivative, on reduction of the keto groups and dehydration, is expected to give cantharic acid.

120. Curcumone.

N. C. Kelkar *and* B. Sanjiva Rao, Bangalore.

Curcumone has been obtained by treatment with alkali of a tertiary alcohol $C_{15}H_{26}O$. The alcohol yields a mixture of oxalic and p-toluic acids on oxidation with nitric acid. Treatment with sulphur yields an aromatic hydrocarbon. On reduction a saturated alcohol $C_{15}H_{30}O$ is obtained showing that it is a monocyclic alcohol with two double bonds.

121. Examination of the chemical constituents of Sweertia chirata.

D. N. Mazumdar *and* P. C. Guha, Bangalore.

The following have been isolated: Stearic, palmitic, cerotic and oleic acid, physosterol, a monohydroxy acid (m.p. 292-93°C), two yellow crystalline phenolic body (m.p. 179-180°C and m.p. 260-61 C), an yellow neutral body (m.p. 196-98°C), a bitter acid called oplelic acid by Hohn (*J.*, 1869, 771) which gave an amorphous light brown bromo compound (m.p. 114-115. 5°C).

122. Constitution of corchoritin. Part II.

N. K. Sen, Dacca.

When corchoritin (*Proc. Ind. Sc. Congress*, 1931) is boiled with alcoholic potash an isomeric lactone ($C_{12}H_{18}O_3$) is formed due to the shifting of the olefinic linking. Confirmation of this is thus afforded by an abortive attempt to isomerise the dihydro-compound with alkali. Corchoritin is readily converted by strong hydrochloric acid into anhydro-corchoritin due to the removal of the hydroxyl group, since while still possessing the lactone group, it yields no longer an acetyl compound. The formation of pyruvic acid by the oxidation of corchoritin proves the presence of the group $CH_3—\overset{|}{\underset{|}{C}}—\overset{|}{\underset{|}{C}}—$as part of the molecule. The immediate reduction of Tollen's reagent by corchoritin points to the presence of an unsaturated lactone of $\beta\gamma$-form. Pyrogenic reduction of corchoritin with zinc dust yields a large volume of gaseous product and a brown semi-solid distillate from which a colourless substance is isolated possessing a characteristic naphthalene-like smell which gives an orange-red picrate melting at 107°.

123. Attempts towards synthesis of cantharidin.

B. H. Iyer *and* P. C. Guha, Bangalore.

The great unstable nature of ortho-dibromo-dimethyl-cyclohexane having yielded only a very meagre quantity of the nitrile (*Proc. Ind. Sc. Congress*, 1930, p. 185, Abstracts, No. 81) synthesis of deoxycantharidin by this method has been suspended.

With a view to see if compounds similar in structure to cantharidin without the two methyl groups, would show vesicant properties, the following reaction has been tried. The disodium salt of di-acetyl-diethyl adipate reacts with the diethyl ester of dibromo-succinic acid with the formation of 1 : 4-diacetyl-1 : 4-dicarbethoxy-2 : 3-cyclohexanedicarboxylate. Similar reaction with symmetrical dimethyldichlorosuccinic ester is being tried to obtain deoxycantharidin.

Studies in the reactions of di-iodofuran with the sodium salts of malonic-, acetoacetic-, and cyanacetic esters are also in progress.

124. Essential oil from the roots of *Aristolochia Indica* (Linn).

B. L. Manjunath, Bangalore.

The pungent smelling oil from the roots of *Aristolochia Indica* was found to possess the following constants :—

$d_{25,\,25}$ 0·9525; $n_{D\,25}$ 1·5023; $[\alpha]_{D\,25}$ −33·11°; ester value 7·3; ester value after acetylation 22·5 ; acid value 2·0.

The oil did not solidify at −15 . When distilled at 1 mm. pressure, boiling commenced at 90 and most of the oil came over between 104 – 106°. Distillation stopped at 148°. The oil is soluble in 5 volumes of 95 per cent. alcohol.

Substances containing phenolic or the lower alkoxy groups are absent. The carbonyl compounds amount to 3 per cent.

125. Essential oil from the seeds of *Psoralea Corylifolia* (Linn).

H. S. Jois *and* B. L. Manjunath, Bangalore.

The seeds of *Psoralea Corylifolia* on steam distillation gave a pale yellow oil possessing a strong and persistent odour (yield 0·05%). The oil had the following constants :—

$d_{25°/25°}$ 0·9150 ; $n_{D\,25}$ 1·4906 ; $[\alpha]_{D\,25°}$ −9·37° ; acid value 4·6 ; ester value 12·0 ; ester value after acetylation 94·3.

The oil partially solidifies and becomes highly viscous when cooled to −15°. The boiling point at 1 mm. pressure ranges between 70 and 152°. At 25° the oil dissolves in half its volume of 90 per cent. alcohol. It is free from phenols and contains 3·2 per cent. of carbonyl bodies.

126. Dipterocarpus Indicus. Resin.

N. C. Kelkar *and* B. Sanjiva Rao, Bangalore.

The oleo-resin examined had the following properties : $d^{25}{}_{25}$=0·9694 ; n^{25}_{D}=1·5075, acid value 18·0, saponification value 23·9, saponification value after acetylation 31·8. An acid melting at 161 has been isolated and the results of its further examination are described.

127. On an azulene from the oleo-resin of *Dipterocarpus tuberculatus*.

P. C. Mitter *and* Asokekumar Sen, Calcutta.

The oleo-resin of *Dipterocarpus tuberculatus* gives on steam distillation about 30 per cent. of sesquiterpenes, boiling between 100° and 105° at 6 mm.

275 grms. of the oil are fractionated at 9 mm. The physical constants are given below :—

Weight of fraction.	Distillation temperature.	Density. (30 C)	Refraction. (30 C)	Rotation.	M_d	M_d for F_2
250 grms.	105°–7°	0·9039	1·4967	+11	66·107	66·1
25	113°–5°	0·9114	1·4997	+128	65·82	

The density and molecular refraction agree with that of a bicyclic sesquiterpene.

On dehydrogenation with sulphur a blue oil was obtained which boiled at 135_{9mm}. It has a density of 0·9742 at 20°C.

It gave a picrate melting at 120°-121° and a styphnate melting at 106°-7°.

On heating with selenium a similar blue oil was obtained which gave a picrate and a styphnate identical with that given by the blue oil obtained from sulphur treatment.

The physical and analytical data agree with that of Guaiazulene described by Ruzicka and Rudolph. (Helv. c. A. 9,118, 1926) *Vide Proc. Ind. Sc. Congress*, Lahore, 1927, pp. 161. The work has been resumed with material of guaranteed purity supplied by the Conservator of Forests, Burma.

128. Studies in abnormal optical rotation. Part IV.

S. M. Mistri *and* P. C. Guha, Bangalore.

In continuation of work reported in the *Proc. Ind. Sc. Congress*, 1931, p. 164, Abstract Nos. 143 and 144, it has been found that

(*a*) pp-diaminodiphenyl-hydrazodicarbonamide,
(*b*) pp-diaminodiphenyl-azodicarbonamide,
(*c*) pp-diaminodiphenyl-glyoxal,
(*d*) pp-diaminoazobenzene,
(*e*) pp-diaminohydrazobenzene,
(*f*) pp-diaminobenzil,
(*g*) 1 : 4-diaminoanthracene,

cannot be made to react with camphorquinone under ordinary known conditions due perhaps to the complex nature and high molecular weights of the diamines. One diamine, viz., $NH_2.C_6H_4\text{-}CH{=}N\text{-}C_6H_4\text{-}NH_2$ has been found to react, but even in their case the isolation of the reaction product in a pure form has not so far been successful.

129. Studies in abnormal optical rotation. Part V.

M. S. Kotnis *and* P. C. Guha, Bangalore.

Camphorquinone-mono-hydrazone has been condensed with several aromatic aldehydes containing a system of conjugated double bonds. With the object of studying the effect of two consecutive nitrogen atoms in an unbroken system of conjugated double bonds the compound obtained from acetamino-benzaldehyde and camphorquinone-mono-hydrazone, has been deacetylated and then condensed with a molecule of camphorquinone.

130. On asymmetric synthesis of organic sulphur compounds.

V. C. Parekh *and* P. C. Guha, Bangalore.

In extension of the work published by Guha and Menon (*Ber.*, 1931, *64*, 544), another attempt has been made by condensing menthyl-β-brompropionate with methyl ethyl sulphide—but the resulting product on being freed from the menthyl group by hydrolysis has been found to be

inactive. With an object to study the effect of exclusion of the possibility of thetine like ring formation in the unsymmetrical sulphonium compounds the action of p-menthylcarboxylate of ω-bromacetophenone and menthyl-δ-brom valerate, etc., on unsymmetrical sulphides is being studied.

131. Analysis of Indian coal tars and their distillation products.

S. K. GANGULI, B. SANJIVA RAO, *and* P. C. GUHA, Bangalore.

Coal tars from Calcutta Oriental Gas Company, Bombay Gas Works and Jamshedpur Coke oven have been analysed.

Calcutta Gas Work's tar: (sp. gr. at 23°C, 1·1688) containing free carbon 9·42%; ash 0·067%; yields on distillation under standard conditions, ammonia water 2·50%; light oil (up to 170°C) – 3·20%; middle oil (170–230°C) 12·50%; creosote oil (230°–270°C) 10·80%; anthracene oil (270°–350°C) 8·20% and pitch 62·80%.

Bombay Gas Work's tar: (sp. gr. at 23°C, 1·1363) containing free carbon 2·55%; ash ·12%; yields on distillation under the same conditions ammonia water 4·0%; light oil 8·2%; middle oil 12·5%; creosote oil 10·4%; anthracene oil 10·2%; pitch 54·2%.

Jamshedpur Coke Oven tar: (sp. gr. at 23°C, 1·2400) containing free carbon 17·43%; ash ·07%; yields on distillation under the same conditions no light oil, but only 20% of it distils between 230–350°; pitch 80%.

132. Examination of the light oil manufactured by Bengal Chemical and Pharmaceutical Works from Calcutta Gas Work's tar.

S. K. GANGULI, B. SANJIVA RAO, *and* P. C. GUHA, Bangalore.

Acids, bases and neutral oils from the light oil are separated and each fractionally distilled with fractionating columns under certain specified conditions and the constituents individually analysed with the following results: ammonia water 0·60%; benzene 7·43%; toluene 7·34%; xylene and other unidentified hydrocarbons in solvent naphtha 6·73%; unsaturated hydrocarbons 1·390%; unidentified hydrocarbons in heavy naphtha 12·18%; pyridine and its homologues 5·57%; phenol 1·34% (by weight); ortho cresol 6·13% (by weight); other higher homologues of the series 7·94% (by weight); naphthalene crude 6·29% (by weight). Hydrocarbons boiling above 200°, 29·14%.

Analysis of the middle oil, creosote oil, anthracene oil and pitch are in progress.

133. Chemical investigation of the high boiling bases of heavy anthracene oil.

S. K. GANGULI *and* P. C. GUHA, Bangalore.

Excepting the isolation of some high boiling bases like di-methylquinolines and acridine in the high boiling fractions of the bases obtained from coal tar, no work appears to have been done on the isolation of the bases occurring in anthracene oil. While analysing the acidic, neutral and basic constituents of the different fractions of coal tar distillation products supplied by Bengal Chemical and Pharmaceutical Works, it was discovered that the heavy anthracene oil (B.P. 350° and upwards) contains as much as 2·5 per cent. bases. The present work embodies the results obtained in the isolation of the ingredient bases by careful fractionation of the products obtained by vacuum distillation under 1 to 25 mm. pressure.

134. Attempts to synthesise diphenylene: isolation of p-diphenylene-di-monosulphide.

V. C. PAREKH *and* P. C. GUHA, Bangalore.

Turner (*Soc.*, 1915, *107*, 1495), Sircar and Majumdar (*J. Indian Chem. Soc.*, 1928, *5*, 417) and Menon (Indian Institute of Science unpublished work) made unsuccessful attempts to synthesise p-diphenylene by the action of metals on suitable aromatic halogen compounds. The action of several desulphurising agents has now been tried upon phenylenedisulphide $(C_6H_4S_2)_x$ and a compound m.p. 148°, possessing the composition C_6H_4S and molecular weight 214–218, has been isolated. From its properties it appears to be p-diphenylene-di-monosulphide

$$C_6H_4 \mathop{<\;>}\limits^{S}_{S} C_6H_4.$$

Further work on the synthesis of the same and similar other substances from suitable pp-diderivatives of diphenyl sulphide, -oxide and -imide is in progress.

135. Morellin.

B. SANJIVA RAO, Bangalore.

The acetyl derivative $C_{38}H_{42}O_{10}$ of this yellow colouring matter gave on oxidation with hydrogen peroxide and potassium permanganate the same acid melting at 49-50°. On reduction a tetrahydro compound was obtained. Distillation over zinc dust yields a hydrocarbon which gives a picrate.

136. Action of chlorine on dilute aqueous solution of some phenols and the effects of the products formed on the taste and odour of water.

B. SANJIVA RAO, Bangalore.

The products formed on gradual addition of chlorine to a dilute aqueous solution of phenol and o-cresol are described.

137. The condensation of resorcinol and secondary alcohols.

J. N. RAY *and* M. A. HAQ.

Resorcinol condenses with isopropyl alcohol and other secondary alcohols in presence of $ZnCl_2$ to give products which are analogous to hexyl resorcinol in constitution and antiseptic properties.

138. Chlorination of derivatives of β-resorcylaldehyde.

M. SESHA IYENGAR *and* K. SANTANAM, Bangalore.

A solution of 2-hydroxy-4-methoxybenzaldehyde yields on chlorination under different conditions, the monochloro and the dichloroaldehydes melting at 107° and 94° respectively. Further, the dichloroaldehyde forms on treatment with nitric acid a dichloro-nitro-derivative which is identical with the product obtained by chlorinating 6-nitroresorcinol-3-methylether, melting at 102°–103°.

The paper deals with the preparation of the above compounds and their constitution.

139. The quarternary salts of p-dimethyl-toluidine.

M. Q. DOJA, Patna.

Several quarternary salts of p-dimethyl-toluidine have been prepared and examined. An improved method for the preparation of trimethyl-p-tolyl-ammonium iodide has been given, and detailed methods of preparation and properties of the others have been noted.

140. Studies in diphenylamine derivatives.

R. N. SEN *and* S. ROY, Calcutta.

Buch (*Ber.*, 1884, 17, 2634) obtained diphenylamine in very poor yields by heating aniline and phenol in presence of calcium chloride at 300°. It is now found that a fairly satisfactory yield of diphenylamine (30%) is obtained by the condensation of aniline and phenol in the presence of anhydrous $ZnCl_2$ and NH_4Cl in an atmosphere of CO_2 at 260°. This new method has been worked out for obtaining unsymmetrical diphenylamine derivatives:—Naphthyl-3-amino-4-methyl-phenyl-amine (m-toluylene diamine-b-naphthol-60% yield), 3-amino-4-methyl-3′-hydroxy-diphenylamine (m-toluylene diamine-resorcinol-40% yield), 3-amino-4′-hydroxy-diphenylamine (m-phenylenediamino-hydroquinone), 3-amino-4-methyl-4′-hydroxy-diphenylamine (m-toluylenediamine-hydroquinone).

These diphenylamine derivatives have all been condensed with benzoic acid by heating with $ZnCl_2$ to yield unsymmetrical 5-phenyl acridine derivatives. These acridine compounds dye silk with shades varying from orange to deep orange. The fluorescence of these compounds is much more intense than that of benzo-flavine.

141. Preparation of p-diethylamino-benzaldehyde.

M. Q. DOJA *and* A. MOKEET, Patna.

An improved method for the preparation of p-diethylamino-benzaldehyde by the interaction of diethylaniline formaldehyde and nitroso-diethylaniline has been described. The preparation of nitroso-diethylaniline from sodium nitrite, diethylaniline and hydrochloric acid has also been investigated in this connection, and a technique has been evolved which gives a high yield of the product in a very pure form.

142. Studies on azo-aldehydes.

R. N. SEN *and* B. BANERJEE, Calcutta.

The azo-aldehydes form an interesting group of compounds as intermediate products in the synthesis of useful dyes with multiple chromophores (cf. Green and Sen, *J.C.S.*, 1912, 101, 1113; Dutt, *ibid.*, 1926, 129, 1171; Sen and co-workers, *J.A.C.S.*, 1924, 46, 111; *J.I.C.S.*, 1928, 5, 487; *ibid.*, 1930, 7, 1; *ibid.*, 1930, 7, 151).

The hydroxy-azo-aldehydes described in this paper have been prepared by the application of Riemer and Tiemann reaction on the azo-phenols; the yields of the aldehydes being increased when a dilute solution (23%) of caustic soda is used and a mixture of chloroform and alcohol (1 : 4) is added slowly to preserve the homogeneity of the reaction mixture. The effect of substituents (*a*) in the phenol residue and (*b*) in the benzene residue of the azo-phenols on the yield of the aldehydes, has been thoroughly investigated and it is seen that substituents generally exert a more or less inhibiting effect, it being more marked when substituting groups are present in the phenol residue. It is interesting to note that whereas the presence of Cl, NO_2 and alkyl groups in the phenol residue exerts a strongly adverse influence on the reaction, the influence of these groups in the benzene residue is not however so strong. The constitution

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of some of the hydroxy-azo-aldehydes has been proved by their synthesis from coupling corresponding diazotised amines with the corresponding hydroxy aldehydes. These aldehydes generally exhibit marked inactivity in forming bisulphite compounds and they give semicarbazones and phenylhydrazones with extreme difficulty and react with NH_2OH and amino compounds to form oximes and azo-methine compounds respectively.

With a view to study the influence of various substituents, viz., OH, NO_2, CH_3, (CH_3 and C_3H_7) some of these aldehydes have been condensed with (*a*) dimethyl aniline and (*b*) resorcin to give azo-triphenyl-methane and azo-pyronine dyes respectively with two chromophores in m-positions to each other.

143. Studies in the mercuration of o-, m-, and p-nitrobenzoic acids and 4-nitrophthalic acid.

P. S. Mayuranathan *and* P. Ramaswami Ayyar,

Bangalore.

The mercuric salts of the above acids were dry heated at about 180° and the resulting products were respectively treated with bromine as well as iodine. The following products were, respectively, identified :—

(1) o-nitro-bromo (or iodo) benzene.
(2) 2-bromo (or iodo) 3-nitro-benzoic acid.
(3) 2-bromo (or iodo) 4-nitro-benzoic acid.
(4) do.

The mechanism of the reactions is discussed.

144. Studies in steric hindrance: Part I.—The isomerism of the monomethyl esters of 3-nitrophthalic acid.

P. Ramaswami Ayyar *and* P. S. Mayuranathan,

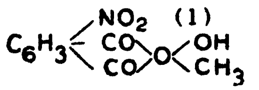
Bangalore.

The two monoesters, melting at 152 and 162 , have been prepared by well-known methods and purified thoroughly by a new and a very short method. Their structures had been till now assumed, without adequate chemical evidence, to be α- and β-monoesters respectively.

Direct evidence for this was sought by dry heating at about 180° of their mercuric salts, followed by halogenation or hydrolysis of the resulting mercurated compounds. In both cases, however, the same products resulted, viz., 2-bromo (or iodo)-3-nitrobenzoic acid, and m-nitrobenzoic acid respectively.

Evidence was also sought by the dry heating of the silver salts and in both cases again only m-nitrobenzoic acid was formed.

Both these evidences point to the fact that the isomerism of the two esters is not due to position and it is suggested that the α- and β-esters may respectively be



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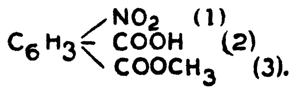


145. 6-Sulpho-salicylic acid.

N. W. Hirwe *and* M. E. Jambhekar.

p-nitro toluene was sulphonated with fuming sulphuric acid at 100°. 2-sulpho-4-nitrotoluene thus obtained was nitrated with fuming nitric acid, when 2-sulpho-4-6-dinitrotoluene was obtained. 2-sulpho-4-6-dinitro-

toluene was oxidised and 2-sulpho-4-6-dinitro benzoic acid was formed. This compound is finally converted into 6-sulpho salicylic acid by reducing the 6-nitro-group, diazotising and converting into –OH group, and eliminating the 4-nitro-group as usual (by reduction, diazotisation and boiling with alcohol).

146. Thiophthalic acids. Part II.—Nitroderivatives.

G. C. CHAKRAVARTI, Bangalore.

In connection with the syntheses of mono- and dithiophthalic acids I have shown (*J. Ind. Chem. Soc.*, 1928, V, 405) that although monothiophthalic acid is very reactive towards oxidising agents yet it can be obtained under certain conditions as a crystalline identity. Dithiophthalic acid, however, is very unstable and cannot be isolated in the free state. Proceeding on the same lines it has been possible to prepare a number of derivatives of nitro-thiophthalic acids. Experiments are being conducted for the isolation of the free acids from these various derivatives.

147. Condensation of phenols and phenolic ethers with acetone dicarboxylic acid. Synthesis of β substituted cyclobutenone carboxylic acids.

V. M. DIXIT, Poona.

The author condensed phenol, anisol and o-cresyl methylether with acetone dicarboxylic acid and obtained a series of p-substituted glutaconic acids. (See *Proceedings of the Indian Science Congress*, 1930.)

The primary product in each reaction was, however, found to be an $\alpha\beta$ substituted cyclobutenone carboxylic acid, the substitution taking place in the para position to the hydroxy or the methoxy group. This compound, on hydrolysis by caustic soda, gave the corresponding glutaconic acid, identical with that mentioned above. Thus, anisol gave

$$\begin{array}{l} CH_3O\,.\,C_6H_4\,.\,C{=\!=\!=}C\,.\,CO_2H \\ \qquad\qquad\quad\;\; | \qquad\;\; | \\ \qquad\qquad\quad\; CH_2{-}CO \end{array}$$

(m.p. 164°, equivalent, 218) which on hydrolysis gave β-4-methoxyphenyl glutaconic acid (m.p. 176° with decomp.). The hydrolysis is so easy that it proceeds in air and in dilute alcohol.

Each of the new cyclic acids gave an isonitroso derivative, anilide, a monochloro compound, a semicarbazone and a mono-acetyl derivative. The last two are titratable acids and can give barium salts.

The new ketonic acids were also obtained from the corresponding glutaconic acids by heating them at their m.pts. and by the action of acetyl chloride or 100 per cent. sulphuric acid.

Further work is in progress.

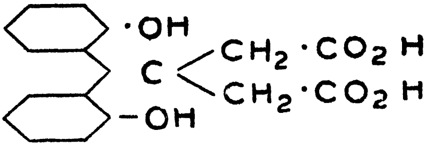
148. Condensation of phenols with acetone dicarboxylic acid. Synthesis of $\beta\beta$ diphenyl glutaric acids.

V. M. DIXIT *and* G. N. GOKHALE, Bombay.

So far, phenols have been condensed with acetone dicarboxylic acid to produce coumarin derivativies (Dey, *Trans. Chem. Soc.*, 1915, *107*, 1606) and glutaconic acids (Limaye and Dixit, *Proceedings of the Indian Science Congress*, 1930), the condensing agent being sulphuric acid.

The authors have found out that two molecules of a phenol condense with acetone dicarboxylic acid to give a new saturated dicarboxylic acid (m.p. 234° decomp.). The equivalent and combustion analysis confer the

formula $C_{17}H_{16}O_6$ on the compound, to which the following structure has been assigned :—



The new acid also gives a dibenzoyl derivative, a diethyl ester and a diacetyl anhydride with acetyl chloride. On treatment with 100 per cent. sulphuric acid, it is decomposed into phenol and o-hydroxy phenylglutaconic acid which is immediately transformed into coumarin-4-acetic acid of (Limaye, *J. I. Chem. Soc.*, 1927, *4*, 154).

A series of the new glutaric acids has been obtained by condensing o-cresol, p-cresol and quinol with acetone dicarboxylic acid.

Further work is in progress.

149. β—(2-Methoxyphenyl)—glutaconic Acid.

D. B. Limaye, Poona.

Limaye and Bhave (*J. Ind. Chem. Soc.*, 1931, *8*, 137) have shown that the product of the direct condensation of anisole and acetone-di-cardoxylic acid is β—(4-methoxyphenyl)-glutaconic acid. The corresponding 2-methoxy acid, $C_{12}H_{12}O_5$, m.p. 151°C., also has now been prepared by the methylation of coumaryl-4-acetic acid (Limaye, *J. Ind. Chem. Soc.*, 1927, *4*, 159). The new acid has been further characterised by the preparation of anhydride, m.p. 101°C. and semianilide m.p. 165°C. (decomp.). The acid can be readily reduced to be corresponding glutaric acid.

Mr. Gagate (Bombay Univ. thesis, 1931) has prepared a similar glutaconic acid from para cresol and the method which appears to be generally applicable is being extended to other cases and the products used for further synthesis here.

150. Chloralides from α-hydroxy carboxylic acids and their reduction products.

N. M. Shah *and* R. L. Alimchandani, Dharwar.

The condensation of chloral with *m*-cresotic acid led to the synthesis of substances related to α-coccinic acid (*J.I.C.S.*, 1931, *8*, 261).

In order to see whether chloral condenses with *m*-cresotic acid or its derivatives in the *meta* position as claimed by Schleussner and Voswinckel, and with a view to synthesise cochinillic acid, we tried to condense chloral with 2-methyl-5-carboxy-4-hydroxy-1 ββ dichloro ethyl benzene and with 4-hydroxy-5-carboxy-2-methyl mandelic acid and their methyl ethers. The former does not condense at all while the latter gave a product which proved to be a chloralide

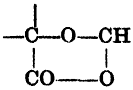
```
  |
—C—O—CH . CCl3.
  |    |
  CO———O
```

This on reduction with zinc and acetic acid gave a substance containing the group

```
  |
—C—O—CH2CHCl2.
  |
 COOH
```

In aliphatic series, chloralides of tartaric and citric acids show a similar behaviour on reduction: tartaric acid chloralide gave a substance

containing the above groups, while citric acid chloralide is reduced to



$. CHCl_2$ without breaking of the chloralide ring.

The chloralides of other α-hydroxy acids, e.g., lactic, mandelic and benzillic acids have been studied and their reduction products are under investigation.

151. m-(p-Dihydroxy) diphenyl phthalide or iso-phenolphthalein.

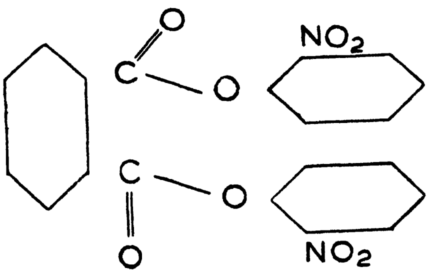
S. Y. KOLHATKAR.

Phenolphthalein and the corresponding ortho compound are known. The meta isomer was prepared by the condensation of phenol with o-(m-hydroxy-benzoyl) benzoic acid in the presence of zinc chloride as condensing agent. The iso-phenolphthalein is a pink coloured hygroscopic crystalline substance melting at 60° (not sharp) and decomposing at 80°.

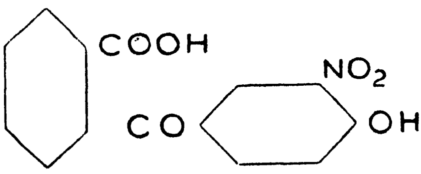
152. Condensation of phthalyl chloride with nitrophenols and their methyl ethers.

S. Y. KOLHATKAR.

By the condensation of phthalyl chloride and nitrophenols in the presence of anhydrous aluminium chloride in carbon tetrachloride, carbon disulphide and acetylene tetrachloride, etc., two types of compounds, viz., phenolic ethers like



and substitution products of hydroxybenzoyl benzoic acid like



were obtained. The latter could also be obtained by the nitration of the hydroxy-benzoyl benzoic acid concerned and so their constitution was confirmed. In presence of aluminium chloride, demethylation of the methyl ethers were found to occur and the products were identical with those obtained with the nitrophenols.

153. Studies in the anthraquinone series: catalytic reduction of anthraquinone derivatives.

P. C. MITTER *and* DILIPKUMAR BANERJEE, Calcutta.

The chloride of anthraquinone -β- carboxylic acid gives on reduction with hydrogen in presence of palladiumised barium sulphate, anthraquinone -β- aldehyde. Diacetyl rhein chloride gives on similar treatment the corresponding aldehyde. Further reduction of the aldehydes into the corresponding alcohols with suitable catalysts is being attempted.

154. Colouring constituents of alkanet root.

G. C. CHAKRAVARTI, Bangalore.

In continuation of the investigation recorded previously (cf. *Ind. Sc. Congress Abstracts*, 1930 and 1931) further work has been carried out in obtaining the dyes in the pure state. Two of the constituents, alkannin and anchusin, on analysis give values for their molecular formula which are closely in agreement with those derived from their derivatives. The formula recently suggested for alkannin is criticised.

155. On munjisthin.

P. C. MITTER *and* HAROGOPAL BISWAS, Calcutta.

When 3-methyl alizarin is treated with sulphuryl chloride in nitrobenzene in presence of iodine, it is converted into 1-2 dihydroxy 3-methyl 4-chloranthraquinone. (M.P. 178°–180°.) On oxidation with nitrous acid in presence of boric and sulphuric acids according to the method of D.R.P. 273341 at a temperature of 160°–165°, it gives purpurin. Oxidation at a lower temperature—140° to 145°—gives rise to an acid melting at 220°–222° (melting point of pseudo-purpurin), but which contains traces of chlorine. From this on reduction with sodium hydrosulphite and ammonia in the cold, purification over the insoluble barium compound and recrystallisation from dilute acetic acid, munjisthin is obtained. It melts at 229 –230 and is chlorine-free. On admixture with natural munjisthin it melts at 227°-228°.

156. Studies in the anthraquinone series:—synthesis of 1, 6 dioxy 3-methyl and 1, 7 dioxy 3-methyl anthraquinones.

P. C. MITTER *and* NRIPENDRANATH CHATTERJI, Calcutta.

When 4-nitrophthalic anhydride is condensed with meta-cresol in presence of aluminium chloride a mixture of two nitrobenzoyl benzoic acids are obtained, one (A) melting at 196 C. and the other melting at 202°–3°. On fusion with potash, the acid (A) gave p-nitrobenzoic acid and an acid which gave a violet coloration with ferric chloride, while (B) gave m-nitrobenzoic acid and an acid which also gave a violet coloration with ferric chloride. (A) is therefore 4-nitro-(2′ oxy-4′ methyl benzoyl) 2-benzoic acid while (B) is 5-nitro (2′ oxy-4′ methyl benzoyl) 2-benzoic acid. On reduction with ferrous sulphate and ammonia, A gave 4-amino-(2′ oxy-4′ methyl benzoyl) 2-benzoic acid (m.p. 218°C.) which on diazotisation gave 4-oxy (2′ oxy-4′ methyl benzoyl) 2-benzoic acid (m.p. 214°–215°C.) On heating with boric anhydride and sulphuric acid, this is converted into 1,7 dioxy 3-methyl anthraquinone (m.p. 255°–56°C.). Similarly, from the acid (B), 5-amino (2′ oxy-4′ methyl benzoyl) 2-benzoic acid (m.p. 237°–38°C.), 5-oxy-(2′ oxy-4′ methyl benzoyl) 2-benzoic acid (m.p. 215°–16°C.) and 1, 6-dioxy 3-methyl anthraquinone (m.p. 213°–14°C.) were obtained.

157. Studies in the fluorenone series.

A. C. SIRCAR *and* K. C. BHATTACHARYYA, Calcutta.

In continuation of the work of the present authors described in the *Journal of the Indian Chemical Society* (1931, Vol. VIII, issue No. 9) the present paper deals with a number of substantive cotton dyes that have been prepared from 2 : 7-diamino-fluorenone (Schmidt and others, *Ann.*, 390, 210) by coupling the tetrazo salt with various phenolic and basic constituents.

An improved method of preparing 2-amino-fluorenone (cf. Diels, *Ber.*, 34, 1748) giving much better yield has been described.

2-Iodo and 2-bromo-fluorenone, which had already been prepared before by other ways (Cf. *Anal. Asoc. Quin. Argentina*, 1297, 15, 5–9 and Schmidt and Bauer, *Ber.*, 1905, 38, 746) have now been prepared from 2-amino-fluorenone via diazo-reaction.

158. Studies in acenaphthenone.

A. C. SIRCAR *and* RAJGOPALAU, Calcutta.

Acenaphthenone has been studied through its 'CH_2-CO' group and the following types of compounds prepared. (1) Pyrylium compounds; (2) Indole derivatives; (3) Quinoline derivatives; and (4) Azo-methine derivatives. The action of nitroso compounds. and aromatic ortho diketones on acenaphthenone has also been studied.

159. Acenaphthene quinone and hydrazine hydrate.

B. K. BANERJEA, Rajshahi.

The action of hydrazine hydrate upon certain ketones and diketones is known. In this paper the action of hydrazine hydrate upon acenaphthene quinone has been investigated. A monohydrazi-compound melting at 136°—137° and its benzaldehyde derivative melting at 223° are described. With two molecules of hydrazine hydrate, instead of obtaining a dihydrazi-derivative, two isomeric compounds styled as (1) acenaphtho-osotriaozole and (2) acenaphtho-aziimide are produced, one melting and decomposing at 225°—226° and the other melting at 175°—176° but not decomposing at 225°—226°.

160. Dyes derived from pyrazindicarboxylic acid: pyrazindicarboxyleins.

S. C. DE *and* P. C. DUTTA, Muzaffarpur.

This paper deals with phthalein dyes which were prepared from pyrazin-o-dicarboxylic acid (Gabriel and Sonn, *Ber.*, 1907, 40, 4851) by condensing it with various aromatic amino and hydroxy compounds and were compared with corresponding dyes derived from phthalic anhydride on the one hand and quinolinic acid (Ghosh, *J.C.S.*, 1919, CXV, 1102) on the other. Apparently the intensity of colour of these dyes has been found to be enhanced but the fluorescent property much decreased. Of the compounds, the m-phenylenediamine condensed product has the highest fluorescence. The use of condensing agent such as sulphuric acid zinc chloride, etc., is not essential as even without them condensation takes place.

161. Dyes derived from acenaphthoquinone and isatin: Quinoxalo-acenaphthazines and quinoxalo-indazines.

P. C. DUTTA *and* S. C. DE, Muzaffarpur.

In continuation of the work of De and Dutta on quinoxalophenanthrazines (*Proc. Indian Sc. Congress*, 1931), the action of diaminoquinoxalin

by Bladin (*Ber.*, 1885, 18, 672) on the aromatic ortho-diketones was further studied. The communication deals with compounds produced by the condensation of diaminoquioxalin with acenaphthoquinone, isatin and their various derivatives. They are all coloured substances ranging from yellow to reddish brown. The compounds are all well-defined crystalline substances characterised by high melting point. They dissolve in concentrated sulphuric acid from which the original substances can be precipitated as a flocculent mass well-suited for dyeing.

162. Vat dyes derived from phenanthraquinone-thionaphthene-phenanthrene indigoes.

P. C. DUTTA, Muzaffarpur.

It has been shown by Friedlander, Herzog and Voss (*Ber.*, 1922, 55, 1591), that phenanthraquinone condenses very easily with hydroxythionaphthene in acetic acid solution containing traces of hydrochloric acid and a violet dye is produced. Later on Pummerer and Luther (*Ber.*, 1931, 64, 831) have obtained that very substance as a red brown crystalline mass by a slight modification of the above method and they say that the original substance as obtained by Friedlander and his collaborators must contain traces of thio-indigo as an impurity. The present author got the substance as a chocolate brown mass and he further extended the reaction by condensing hyroxythionaphthene with various derivatives of phenanthraquinone. The condensation products with bromo and nitrophenanthraquinones are found to be violet dyes whereas those with amino and hydroxyphenanthraquinones, black or brownish black. The substances dissolve in conc. sulphuric acid with a green, violet green or violet brown colour and the original dyes can be precipitated back by treatment with water which precipitates are found to be quite suitable for dyeing on wool from an acid bath. Except the bromo-compounds, they dissolve in hydrosulphite vat with a yellowish brown colour from which the original dyes are precipitated by oxidation with air.

163. Indole transformation of the pyrryl ketones.

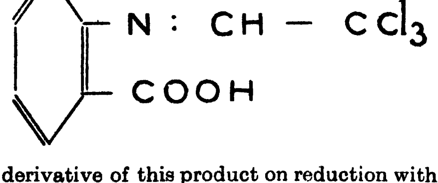
A. U. QUERESHI *and* J. N. RAY.

A number of pyrryl methyl ketones have been synthesised and converted into pyrrindoles. The mechanism of Fischer's indole transformation has been studied. The synthetic pyrrindoles may be precursors of tryptophane and proline in the hydrolysis of the proteins.

164. A new synthesis of indigo.

K. S. VAIDYANATHAN.

Anthranilic acid (1 mol.) is condensed with chloral (1 mol.) to give a product (*Vide Ber.*, 1895, *28*, 2812, and *J.Am. C.S.*, 1908, *30*, 139) of the formula



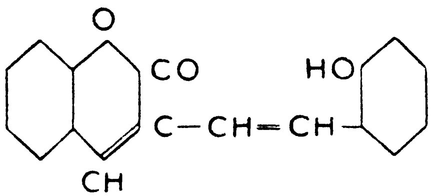
The acetyl derivative of this product on reduction with zinc and acetic acid gives two products, one in a good yield and the other in small quantities.

The reduction product formed in larger quantities is fused with sodium hydroxide, diluted with water, and oxidised with atmospheric air, when it yields indigo.

165. Condensation of salicyl-aldehyde with sodium succinate.

B. B. DEY *and* Y. SANKARANARAYANA.

Dyson (*Trans.*, 1887, 63) who studied the reaction between salicylaldehyde (2 mols.), sodium succinate and acetic anhydride at a high temperature, obtained 3, 3′-dicoumarin as the sole product of the reaction. It is now found that a small amount of coumarin-3, acetic acid is also formed in this reaction if only 1 mol. of the aldehyde is taken : in a typical experiment carried out under Dyson's condition, 0·15 gram of coumarin-3, acetic acid crystallising in yellow plates melting at 158°C (methyl ester, colourless needles, m.p. 77°C.), was obtained from 3 g. of salicyl-aldehyde. If, however, the acetic anhydride be replaced by succinic anhydride, coumarin-3, acetic acid is obtained as the main product of the reaction. The following results were obtained from a typical experiment : 3 g. salicylaldehyde, 4 g. sodium succinate and 3 g. succinic anhydride, on heating to 180°C. for four hours, gave 1·2 g. coumarin-3, acetic acid, 1 g. 3, 3′-dicoumarin (m.p. 315°C.), and 0·7 g. of another crystalline product (m.p. 207°C.) soluble in cold alkali but insoluble in alkali carbonate, which, from analyses and chemical behaviour, appears to have the structure given below :—



It forms an acetyl derivative melting at 177°C.

166. The coumarin condensation.

V. M. DIXIT *and* G. N. GOKHALE, Bombay.

Dey (*Trans., Chem. Soc.*, 1915, *107*, 1606) obtained coumarin acetic acids by condensing phenols with acetone dicarboxylic acid. In each reaction, he obtained a coumarin acetic acid which changed m.pts. with a change in the solvent of crystallisation. In some cases the m.pt. of the crystallised substance was lower than that of the crude product.

With a view to investigate into the strange phenomenon, the authors condensed phenol and the three cresols with acetone dicarboxylic acid. In each case, two interconvertible compounds were isolated from the crude product. Thus, m-cresol gives a compound (A) (m.p., 168° decomp.) which agrees in composition and properties with 7-methyl coumarin-4-acetic acid and gives 4 : 7-dimethyl coumarin on decomposition at the m.pt. ; and another compound (B) (m.p., 210° decomp.) which contains a molecule of water less than (A) and gave also 4 : 7 dimethyl coumarin on decomposition at the m.pt. The mixture of (A) and (B) melts at 180°–190° decomp.

(A) can be converted into (B) by 100 per cent. sulphuric acid and hydrolysis by NaOH promotes the reverse change which can proceed of its own accord in air and in dil. alcohol. Similar pairs of definite compounds showing clear differences in equivalents and analysis have been obtained from each of the other phenols mentioned above.

The work is being continued.

167. Introduction of arsenic in substituted coumarins.

M. GOSWAMI *and* H. N. DAS GUPTA.

Substituted amino coumarins have been converted into corresponding arsenic acids by means of Bart's reaction.

168. 5-Amino-ortho-coumaric acid.

R. N. SEN *and* B. BANERJEE, Calcutta.

The diazo-transformations of 5-amino-ortho-coumaric acid are described in this paper. 5-amino-ortho-coumaric acid (m.p. 194°) has been obtained by the reduction (with iron and hydrochloric acid) of 5-nitro-ortho-coumaric acid which is readily obtained in quantity from 6-nitro-coumarin (Sen and Chakraverti, *J. Indian Chem. Soc.*, 1930, 7, 247).

169. 6-Aldehyde-4-methyl-α-naphtha-pyrone.

R. N. SEN *and* G. MUKHERJEE, Calcutta.

6-aldehydo-coumarin was previously obtained by the application of Reimer and Tiemann's reaction on coumarin (Sen and Chakraverti, *J. Am. Chem. Soc.*, 1928, 2428). 4-methyl-α-naphtha-coumarin (pyrone) similarly yields about 30 per cent. of an aldehyde, the aldehydic group entering the 6-position (para to original OH group), there being no other possibility. The aldehyde does not melt up to 300°, readily gives a phenyl hydrazone (m.p. 125°), a semi-carbazone (m.p. 260°) and an oxime (which does not melt up to 260°).

The aldehyde condenses with dimethyl aniline and o-cresotinic acid to produce triphenyl methane dyes (lenco); which on oxidation produce respectively a bluish-green shade and a golden yellow shade on silk and wool. A pyronine dye has been obtained by condensing the aldehyde with four molecules of resorcinol, when the CO group in the lactone ring as well as the aldehyde group react. Silk is dyed a bright orange shade by the sodium salt of this compound.

170. The condensation of α-formylphenylacetonitriles with phenols.

I. C. BADHWAR *and* K. VENKATARAMAN.

With Baker and Menon we have shown (*J.C.S.*, 1931) that the Hoesch reaction of α-formylphenylacetonitrile (I) with resorcinol, phloroglucinol and orcinol takes an abnormal course and leads to the coumarin in every case. The present work concerns the condensation of (I) with hydroxy-hydroquinone triacetate (II), α-naphthol (III) and β-naphthol (IV). (II) gave a mixture of products of which the expected coumarin or isoflavone was not one; for comparison, 6 : 7-dihydroxy-3-phenyl-coumarin was prepared by treatment of (II) with oxymethylene phenylacetic ester and sulphuric acid. (III) gave 3-phenyl-1 : 2-α-naphthapyrone. Two substances were obtained in the case of (IV); one was identical with the product of the action of sodium phenyl acetate and acetic anhydride on 2-naphthol-1-aldehyde; the other is probably 3-phenyl-1 : 2-β-β′-naphthapyrone.

171. Chromones derived from 2-phenylacetyl-1-naphthol and 2-benzylacetyl-1-naphthol.

U. S. CHEEMA *and* K. VENKATARAMAN.

2-phenylacetyl-1-naphthol (I) and 2-benzylacetyl-1-naphthol (II) have been made by the Nencki reaction—heating α-naphthol with acid and

zinc chloride. (I) and (II) undergo Robinson's chromone condensation readily. 2-Methyl-3-phenyl-1 : 4-α-naphthapyrone (III), 2 : 3-diphenyl-1 : 4-α-naphthapyrone (IV), 2-methyl-3-benzyl-1 : 4-α-naphthapyrone (V) and 3-benzyl-α-naphthaflavone (VI) have thus been prepared. (III), (V) and (IV) were reported to have been made by Jacobson and Ghosh (J.C.S., 1915, 1916) by condensing α-naphthol with β-ketonic esters; but their compounds are shown to be coumarins. (I) did not react with ethyl formate and sodium ; (II) gave a mixture of 3-benzyl-1 : 4-α-naphthapyrone and 2-hydroxy-3-benzyl-α-naphthapyranone.

172. 2-Styrylchromones.

U. S. CHEEMA, K. C. GULATI, *and* K. VENKATARAMAN.

The action of cinnamic anhydride and sodium cinnamate on resacetophenone, phloracetophenone and 2-acetyl-1-naphthol gave amorphous products from which no pure styrylchromone could be isolated. Respropiophenone, 2-propionyl-1-naphthol, 2-phenylacetyl-1-naphthol and 2-benzylacetyl-1-naphthol, however, reacted readily with cinnamic anhydride and with p-methoxycinnamic anhydride giving 3-substituted 2-styrylchromones. Two other possible methods for the preparation of styrylchromones unsubstituted in the 3-position were investigated. The first was to condense ketones such as o-hydroxyacetophenone with cinnamaldehyde, convert the cinnamylideneacetophenone to the 2-styrylchromanone and then treat the latter with phosphorus pentachloride; the chromanone change did not proceed. The second method was a re-examination of that due to Heilbron, Barnes and Morton and consisted in the condensation of 2-methylchromones with aromatic aldehydes. The process was found to be much more generally applicable than Heilbron and others considered and numerous 2-styrylchromones and 2-styrylnaphthapyrones have thus been prepared. The synthesis of certain 2-styrylchromones, having a possible bearing on the constitution of plant pigments such as fukugetin and pratensol, is in progress.

173. α-Naphtha-γ-pyrones.

K. S. KANG *and* K. VENKATARAMAN.

Bhullar and one of us having shown earlier (*J.C.S.*, 1931) that the action of acid anhydrides on 2-acetyl-1-naphthol (I) leads to a mixture of naphtha-γ-pyrones and their 3-acylated derivatives difficult to separate, further naphthapyrones have now been made by the chalkone method. The condensation of (I) with o-methoxybenzaldehyde and 3 : 4 : 5-trimethoxybenzaldehyde respectively gave the corresponding 2-benzylideneacetyl-1-naphthol; treatment of the acetate with bromine yielded the dibromide, which was then treated with alcoholic potash. 2′-Methoxy-α-naphthaflavone and 3′ : 4′ : 5′-trimethoxy-α-naphthaflavone thus obtained, were then demethylated to the corresponding hydroxy-compounds whose reactions and dyeing properties are recorded.

174. Condensation of acetone-di-carboxylic acid with paracresolmethylether.

D. B. LIMAYE *and* G. R. GOGOTE, Poona.

It has been shown by Limaye and Bhave (*J. Ind. Chem. Soc.*, 1931, *8*, 137) that when anisole is condensed with acetone-di-carboxylic acid β (4-methoxy phenyl)—glutaconic acid is produced. It seemed of interest to investigate a case where the para position is already occupied.

The condensation with paracresolmethylether has yielded under suitable conditions four products :

(*a*) the already known coumaryl-4-acetic acid from paracresol

(*b*) a dibasic acid—β (2-methoxy-5-phenyl) glutaconic acid, $C_{18}H_{14}O_5$, m.p 169°C (decomp.)
(*c*) a monobasic acid-3-keto-4-methyl-7-methoxy-hydrindenylidene-acetic acid, $C_{13}H_{12}O_4$ m.p. 218°C (decomp.) and
(*d*) a high melting acid of unknown constitution which gives (*c*) on heating with sulphuric acid.

Treatment of (*a*) with methyl sulphate gives (*b*) which as a β substituted glutaconic acid gives an anhydride m.p. 117°C, titrating as a monobasic acid, an acidethylester, m.p. 82°C, a semianilide m.p. 146°C, an anil m.p. 225°C and other derivatives.

The constitution of (*c*) is supported by its formation from (*b*) by elimination of water, production of the appropriate phthalic anhydride, m.p. 186°C on oxidation, formation of a semicarbazone m.p. 252°C and a nitrosoderivative m.p. 215°C (decomp.) from the ethyl ester m.p. 158 C.

175. Flavanes.

K. S. NARANG *and* J. N. RAY.

Chalcones on catalytic reduction are converted into dihydro derivatives which are transformed to flavanes analogous to catechin.

176. Attempt to synthesise benzopyrillium salts.

M. GOSWAMI *and* A. K. CHAKRAVARTI.

Condensation of coumarin with resorcin with $POCl_3$ gave a compound which from analytical results has been suspected to be a benzopyrillium salt and confirmation of the view is being made by preparing it from salicylic aldehyde and resacetophenone.

177. The reaction of pyridine with 1 : 3 dichloro-4 : 6 dinitrobenzene.

H. S. JOIS *and* B. L. MANJUNATH, Bangalore.

When pyridine is warmed with 1 : 3 dichlore-4 : 6 dinitrobenzene vigorous reaction sets in with evolution of a small amount of hydrochloric acid. The resultant mixture was separated into two constituents. One of these, a colourless compound ($C_{16}H_{12}O_4N_4Cl_2$), is highly soluble in water and the chlorine in it is quantitatively precipitated by aqueous silver nitrate. To this is assigned the dipyridonium structure. It appears to melt at 132°, but changes over at that temperature to the second substance giving off HCl. This latter is a halogen free yellow compound (decomposes at 180°) and its structure is being investigated.

178. β-β Diaceto α γ dibenzoyl propane.

A. U. QUERESHI *and* J. N. RAY.

The above substance and analogous bodies have been synthesised and converted into dihydro pyridines. Ketocyclol tautomerism of the above has been studied.

179. Condensation of ethyl aceto-succinate and ethyl formyl-succinate with aromatic amines.

B. B. DEY *and* A. K. LAKSHMINARAYANAN.

The condensation has been effected by four different methods, viz., (*a*) interaction in the cold by leaving the mixture for a week in a desiccator over sulphuric acid, (*b*) rapidly heating the mixture to the boiling

point and maintaining at this temperature for a few minutes only (cf. Ewins and King, *J.C.S.*, 1913, 104), (*c*) mixing the components with excess of glacial acetic acid and boiling for several hours (cf. H. Liebermann, *Ann.*, 1914, *404*, 272), and (*d*) mixing the components with a few drops of diethyl amine, leaving at the ordinary temperature for 2-3 days, and then heating to the boiling point for a few minutes (cf. Gibson, etc., *J.C.S.*, 1926, 2247). The following products have been isolated and analysed, and their properties studied. (1) aceto-succinic monanilide, $CH_3.CO.CH.(CONHPh).CH_2.COOEt$, m.p. 90°, (2) 2-hydroxy-4-methyl-quinoline-3, acetic acid, m.p. 180°, (3) anilino-aceto-succinic dianilide, $CH_3.C(NH.Ph):C(CO.NH.Ph).CH_2.CO.NH.Ph$, m.p. 194°, (4) p-toluidide of 2, 6-dimethyl-4, hydroxy- (or 4, 6-dimethyl-2, hydroxy-) quinoline-3, acetic acid, m.p. 268°, (5) β-anilido-itaconic acid diethyl ester, $Ph.NH.CH{=}C(COOEt).CH_2.COOEt$, m.p. 103°, and (6) β-p-toluidino-itaconic acid diethyl ester, $CH_3.C_6H_4.NH.CH{=}C(COOEt).CH_2.COOEt$, m.p. 110°.

180. 4-Methyl-quinoline-α-pyrone.

R. N. SEN *and* G. MUKHERJEE, Calcutta.

A substituent in the phenol molecule exerts a marked influence on coumarin formation by Pechmann's method (Cf. Clayton, *J.C.S.*, 1908, 2016). In order to study the influence of a hetero-ring attached to the phenol on coumarin formation, the condensation of 8-oxy-quinoline with acetoacetic ester has been investigated, and it is found that 8-oxy-quinoline like dimethyl-m-amino-phenol (*Ber.*, 1897, 30, 277) condenses with acetoacetic ester in absolute alcoholic solution in the presence of zinc chloride giving an α-pyrone derivative in small yield. It dissolves both in mineral acids and hot caustic alkalies. It is peculiar that this quinoline-α-pyrone exists in two isomeric forms though it has not been possible to offer a plausible explanation for this isomerism.

181. 2′ : 4′ Diacetoxy phenyl 2-methyl 6 : 7 methylenedioxy 8-methoxy 1 : 2 : 3 : 4 tetrahydro isoquinoline and its action on uterus excised or *in situ*.

B. D. KOCHHAR *and* J. N. RAY.

182. Organo-metallic derivatives of quinoline and isoquinoline.

R. N. SEN *and* G. MUKHERJEE, Calcutta.

Quinoline and isoquinoline derivatives with antimony in the nucleus have now been prepared for the first time by Bart's reaction on 3-, 5-, 6-, 7-, 8-aminoquinolines and 5 (or 8)-amino-isoquinoline. It has been observed that the position of the amino group in the quinoline nucleus is of very great consequence: the 6- and 8-amino-quinolines yield only 10–15% of the stibinic acids, while 25–30% of the stibinic acids are obtained from 3-, 5-, and 7-amino-quinolines. The 2- and 4-amino-quinolines do not even respond to diazo reaction.

It has also been possible to obtain quinoline derivatives with a mercury atom in the nucleus by the action of mercuric acetate on 8-oxy-quinoline. The fact that 5-bromo-8-oxy-quinoline and 5: 6-dibromo-8-oxy-quinoline are mercurated as easily as 8-oxy-quinoline shews that the mercury atom enters into the ortho position to the hydroxyl group.

The study of the therapeutic value of these organo-metallic derivatives of quinoline and iso-quinoline may lead to interesting results.

183. The reaction between phenylhydrazine and quinolinic acid.

A. C. SIRCAR *and* P. R. SEN GUPTA, Calcutta.

The action of phenylhydrazine with quinolinic acid has been studied and by taking different proportions of the reacting substances and using different temperatures, four different products have been obtained.

184. Anhydro-cotarnine derivatives.

G. S. AHLUWALIA, B. D. KOCHHAR, *and* J. N. RAY.

Cotarnine condenses with phenols in presence of sodium ethoxide. A number of these substances are described and a comparative study of their action on paramoecia is undertaken.

185. Antimalarials. Part II.

G. S. AHLUWALIA, B. D. KOCHHAR, *and* J. N. RAY.

A number of cotarnine derivatives have now been synthesised and their anti-malarial properties fully investigated.

186. Synthesis in the phenanthren sub-group of iso-quinoline alkaloids.

K. S NARANG, G. S. AHLUWALIA, *and* J. N. RAY.

O-nitroaldehydes have been condensed with isoquolinium methohydroxides and by Pschorr transformation converted into phenanthren derivatives.

187. Studies in acridine derivatives.

R. N. SEN *and* S. ROY, Calcutta.

This investigation deals primarily with the preparation of various acridine derivatives by new methods with a view to study the effect of the nature and position of different auxochromic groups on the colour and fluorescence of acridine dyes.

The method of Meyer and Gross (*Ber.*, 1899, 32, 2356) for the preparation of typical acridine dye, benzo-flavine, from m-toluylene diamine and benzaldehyde, involves three different operations; but it has been now found possible to obtain this dye in a single operation using sulphuric acid (d. 1·84) as the condensing agent at the temperature of the boiling water bath, the condensation of the aldehyde with the diamino and subsequent acridine ring formation with the elimination of NH_3 and final oxidation all taking place simultaneously. Different aldehydes (e.g., dimethyl-p-amino-benzaldehyde, o- and p-nitro-benzaldehydes anisaldehyde, vanilin, furfuraldehyde, cinnamicaldehyde) have thus been successfully condensed with m-toluylene diamino to produce acridine dyes with different substituents in the 5-phenyl residue. It is interesting to note that proflavine base is also thus readily obtained from tetra-amino-diphenyl methane.

All known acridine dyes contain the amino group in the para position to the central C atom. Acridine dyes with the amino group in the m-position to the central C atom and therefore in the para position to the N atom have now been prepared for the first time by condensing tetramethyl-p-p-diamino-diphenyl-methane (reduction product of Bindschedler's green) with benzoic acid and p-nitro benzoic acid.

From a study of the different acridine derivatives it is concluded that

the acridine chromophore is really a very weak one and as such colours varying from yellow to deep orange can only be exhibited by acridine dyes.

It is remarkable that tetrazotised pro-flavine and benzoflavine couple with 'R' salt to form dyes substantive to cotton, producing red and bluish-red shades respectively.

188. Studies in heterocyclic compounds.

A. C. Sircar *and* S. C. Sen, Calcutta.

The reaction of o-amino-hydroxy group in 2-hydroxy-3-amino-phenazine has been studied and it has been found that unlike ortho-amino-phenol, the hydroxy amino phenazine is not so well adapted for the building of heterocyclic compounds. Evidently the already existing azine ring in the phenazine strongly militates against the otherwise easy reactivity of the orthoamino-hydroxy groups.

189. The influence of attached rings on the formation of heterocyclic compounds. Part I.

T. N. Ghosh, Bangalore.

It has already been shown (*Jour. Indian Chem. Soc.*, 1929, *6*, 181) that o-phenylenediaryldithiocarbamides are easily converted into thiohep-tadiazine derivatives when treated with strong hydrochloric acid. In continuation of the same work, some new substituted dithiocarbamide derivatives of ethylene, naphthalene, phenanthrene have been prepared and subjected to the action of strong hydrochloric acid with the object of examining the effect of one or more benzene rings on their case and nature of transformation into cyclic structures. From the results that have been obtained, it is concluded that the benzene ring helps the ring-formation and that the effect appears to increase with the increase in the number of benzene rings.

190. The influence of attached rings on the formation and stability of heterocyclic compounds. Part II.

T. N. Ghosh, Bangalore.

In order to confirm further the idea developed in Part I, β-amino-propionic acid has been condensed with various thiocarbimides to yield a mixture of a diazine and thiazine derivatives with the elimination of a molecule of water. It has already been shown (*Jour. Indian Chem. Soc.*, 1930, *7*, 981) that the condensation of anthranilic acid with various thio-carbimides yields quinazoline derivatives. The evidence which has now been obtained from the action of hydrolysing agents on the above diazine and quinazoline derivatives points clearly to the well-marked influence of the benzene ring in increasing the stability of the heterocyclic systems. Similarly the velocity coefficients for the hydrolysis of succinimide, isatin, etc., on one hand and phthalimide, naphthisatin on the other are being studied with a view to obtain further evidence in this connection.

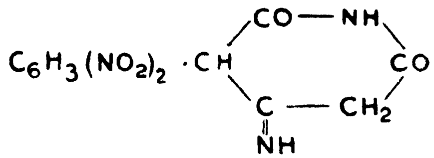
191. Interaction of dinitro-chlorobenzene with cyanoaceta-mide.

Pulinbehari Das *and* H. K. Sen, Calcutta.

Dey has found (Private communication) that when 1 mol. of 2-4-dinitro chlorobenzene is boiled with an alcoholic suspension of 1½ mol. of sodio-cyanacetamide for several hours a compound melting at 188°C after purification by crystallisation from acetic acid is obtained. It imparts an intense blue colouration with minutest quantities of alkali and gives even with ordinary distilled water a bluish tint, which disappears on acidification.

As such a behaviour appears unlikely from the ordinarily expected course of reaction the subject was investigated under different experimental conditions. For example, sodio-cyanacetamide prepared in absolute alcoholic suspension was washed thoroughly with ether and benzene and subsequently boiled under reflux for ten hours with 2·4-dinitrochlorobenzene in benzene suspension on the water bath. The separated product this time, after acidification, could be crystallised from boiling water with the help of animal charcoal when a very pale yellowish looking product of the composition $C_6H_3(NO_2)_2CH(CN)CONH_2$ melting at 166°–168°. On hydrolysis with 80 per cent. sulphuric acid, the dinitro·phenylacetic acid melting at 188°C was obtained establishing thus the constitution of the condensation product. It gives a red colouration with alkalies as distinct from the blue colour given by Dey's compound. On mixing equimolecular quantities of our compound and cyanoacetamide and boiling for some time the red colouration changes to blue but so far no pure compound has been isolated from the reaction product. The conjecture however is that Dey's compound is probably a glutazine of the following composition :—

$C_6H_3\ (NO_2)_2Cl + 2CN\ (CH_2)\ CONH_2 \rightarrow$



On hydrolysis, the compound yielded a derivative insoluble in alkali melting at 221°C which is under investigation.

192. Endothio and endo-imino triazoles and thiobiazoles.

S. L. Janniah *and* P. C. Guha, Bangalore.

The work reported in the *Proc. Ind. Sc. Congress*, 1931, Abstract No. 165, p. 169, has been extended further and several other isomeric endo-compounds in the triazole series have been isolated. 2 : 5-dithiol-1 : 3 : 4-thiobiazole on being treated with acetic anhydride gives an acetyl compound which on de-acetylation gives neither the original dithiolthiobiazole nor any isomeric endothio compound as expected from previous experience—but 2 : 2′-dithiol-dithiobiazole sulphide. Further work in this direction, by way of exploiting the possibility of formation of open chain, closed chain and bridged sulphides—is being continued with aliphatic and aromatic dithiol compounds.

193. Synthesis of phenylthioxanthenes.

Gopal V. Nevgi *and* G. C. Chakravarti, Bangalore.

For the preparation of phenylthioxanthenes a more direct method, than the condensation of hydroxy benzhydrols with aromatic mercaptans (Betrabet and Chakravarti, *Proc. Indian Sc. Congress*, 1930) in presence of zinc chloride, was tried by condensing substituted diphenyl sulphides with aromatic aldehydes in presence of concentrated sulphuric acid. The products obtained were mostly the expected thioxanthenes and sometimes their sulphonic acid derivatives containing one or more sulphonic acid groups in the molecules. The yields were fairly good.

Phenylthioxanthenes were in this way obtained from the following sulphides, (1) p-methoxy-p′methyldiphenyl sulphide, (2) m-methoxy-p′ methyldiphenyl sulphide, (3) p-methoxy phenyl β-naphthyl sulphide, (4) m-methoxy phenyl β-naphthyl sulphide, and the following aldehydes, (1) benzaldehyde, (2) p-nitro-benzaldehyde, (3) m-nitro-benzaldehyde, (4)

vanillin, (5) anisaldehyde, etc. The detailed investigation of the properties of the compounds obtained is being carried out. It is anticipated that the xanthenes derived from the m-methoxy compounds will on oxidation first yield the carbinol bases which on hydrolysis will then be converted into quinonoid derivatives.

194. Organo arsenic compounds.

D. N. MAZUMDAR *and* P. C. GUHA, Bangalore.

The work already reported (*Proc. Ind. Sc. Congress*, Abstracts, 1930, 1931) has been extended further and a number of aromatic diamines like pp-diaminodiphenyl-urea, -oxamide, -malonamide, -succinamide, -carbohydrazide, -hydrazodicarbonamide, etc., have been arsenated by different methods.

195. Preparation of mercury-organic compounds with the help of mercuric chloride and sodium bicarbonate in presence of glycerol. Part II.

P. NEOGI *and* M. M. GHOSE.

The method employed by Neogi and Chatterjee for mercuration of organic compounds has been extended to thymol, o-, m-, and p- toluidines, a- and b-naphthol and a- and b-naphthylamines.

196. Vasicine.

K. S. NARANG, S. KRISHNA, T. P. GHOSH, *and* J. N. RAY.

New oxidation products and further degradative experiments throwing light on the constitution are now described.

197. The alkaloids of kurchi bark (Holarrhena antidysenterica). Part II.

SUDHAMOY GHOSH *and* I. B. BOSE, Calcutta.

In a previous paper (Ghosh and Ghosh, *Jour. Ind. Chem. Soc.*, Vol. V, p. 477, 1928) it was shown that the kurchi bark contains, besides a little conessine, two new alkaloids designated by the authors as kurchine and kurchicine, the low-melting alkaloid, kurchine, occurring in largest amount. These two new alkaloids have now been further purified and properties of the bases and some of their derivatives have been studied. Kurchine, which has crystallised in colourless needles, is shown to have the composition $C_{23}H_{38}N_2$; m.p. 75°; $[\alpha]_D^{32} + 6{\cdot}4°$ (in absolute alcohol), -7·57° (in chloroform). The acid oxalate, which crystallises in colourless prisms, melts at 221° (whereas that of conessine melts at 280°). The hydrochloride, hydrobromide, hydriodide, sulphate, platinic chloride have been crystallised and analysed.

The second alkaloid kurchicine, which crystallised in colourless needles, is shown to have the composition $C_{20}H_{36}N_2O$; m.p. 175°; $[\alpha]_D^{32} - 11{\cdot}44°$ (in chloroform), -8·45° (in absolute alcohol). The hydrochloride, hydrobromide, oxalate, sulphate, auric chloride and platinic chloride have all been analysed.

The results confirm that these alkaloids are different from conessine and holarrhenine isolated from the African holarrhena.

198. The chemical examination of the bark of Moringa Pterygosperma.

SUDHAMOY GHOSH *and* ASHUTOSH DUTT, Calcutta.

A preliminary extraction with solvents gave the following extractives: petroleum ether 0·71 per cent., sulphuric ether 6·47 per cent., chloroform 0·68 per cent. and absolute alcohol 2·17 per cent. The alcoholic extract gave strong reactions for alkaloids. An assay of the bark showed the presence of 0·105 per cent. of total vegetable bases. For isolation of the bases the bark was extracted by cold percolation with rectified spirit, the alcohol distilled off and finally concentrated in vacuo. The residue was extracted with dilute acid, filtered extract made alkaline and extracted with ether and finally with chloroform. The residue from the solvents was dissolved in alcohol, neutralised with HCl and evaporated. The dry residue was extracted with hot chloroform. The insoluble portion was repeatedly recrystallised from alcohol and the hydrochloride was obtained in colourless glittening plates, m.p. 254·2°. The platinic chloride crystallised in yellow rectangular plates of m.p. 221°, the picrate crystallised in yellow wooly needles m.p. 195°. The free base remained liquid at room temperature and could not be crystallised. The hydrochloride of the second base, soluble in hot chloroform, has not been obtained crystalline, but it had a strong physiological action.

199. Some new hydrocupreidine derivatives. Part II.

SUDHAMOY GHOSH *and* N. R. CHATTERJEE, Calcutta.

In a previous communication (*Jour. Ind. Chem. Soc.*, 1931, vol. 8, p. 257) we have described the preparation of some isoalkyl derivatives of hydrocupreidine. In the present paper the preparation of some of the normal alkyl derivatives of hydrocupreidine is described. They have been prepared, as before, by heating potassium hydrocupreidinate in absolute alcohol with the alkyl iodide using molecular copper as catalyst. The new bases, which crystallised well from acetone, were:—

(1) Normal propyl hydrocupreidine $C_{22}H_{30}O_2N_2$ (m.p. 182°)
(2) Normal butyl hydrocupreidine $C_{23}H_{32}O_2N_2$ (m.p. 176°)
(3) Normal amyl hydrocupreidine $C_{24}H_{34}O_2N_2$ (m.p. 164°)
(4) Normal heptyl hydrocupreidine $C_{26}H_{38}O_2N_2$ (m.p. 158°)
(5) Normal octyl hydrocupreidine $C_{27}H_{40}O_2N_2$ (m.p. 151°)

The antiseptic and other properties of iso-alkyl derivatives are still being studied. The use of any of these derivatives as local anaesthetic, bactericide or antiseptic would help to utilise the starting material, hydroquinidine, a normal constituent of the cinchona bark, now without any use.

200. Chemical examination of the roots of *Aristolochia Indica* (Linn.).

B. L. MANJUNATH, Bangalore.

The roots of *Aristolochia Indica* enjoy considerable reputation in Ayurvedic medicine as remedy for snake-bites, etc. A tincture is also used as a bitter tonic. Mention is made in the literature of the occurrence of a volatile oil and of an alkaloidal constituent.

The paper presents the results of a systematic study of the chemical constituents.

Successive extraction with the following solvents	Per cent. of extract.
Petroleum ether (b.p. 40–50°)	2·7
Ethyl ether	0·9
Chloroform	1·0
Ethyl acetate	0·5
Ethyl alcohol	5·1
Total	10·2
Essential oil content	0·46

An aqueous extract of the roots gave tests for the presence of starch and a small amount of reducing sugars. No tannin material could be detected.

The alkaloidal content was found to vary very greatly in different samples. An ether soluble base has been obtained in a pure state and its derivatives studied.

201. Oil from the fruits of Solanum Xanthocarpum.

SHANTI SHETH *and* D. D. KANGA.

The drug belongs to the Natural Order Solanaceae.

The oil was obtained by extracting the powdered fruits with petroleum ether in a Soxhlet apparatus.

It gives the following analytical data:—

Sp. Gr. at 15°C	0.9663
Refractive index at 40°C	1·4695
Iodine value	122·08
Saponification value	184·1
Reichert Meissl value	00·0
Acid value	64·75

Further work on the oil is in progress.

202. Oil from the seeds of Celastrus peniculatus.

SHANTI SHETH *and* D. D. KANGA.

The drug belongs to the Natural Order Celastrineae.

The oil was obtained by extracting the powdered seeds with petroleum ether in a Soxhlet apparatus. The yield of the oil was found to be 35 to 40 per cent. It is reddish brown in colour, bitter in taste and having a characteristic odour of its own. The oil was also obtained by pressing in the country Ghani. Table I. includes analytical data obtained by Solanki, Nargund and Kanga and the authors.

TABLE I.

	Sheth and Kanga.		Solanki, Nargund and Kanga.*
	Pet. Ether extracted oil.	Ghani oil.	Pet. Ether extracted oil.
Sp. Gr. at 15°C ..	0·9670	0·9705	0·9566
Refractive index n_D at 40°C	1·4701	1·4591	1·4547
Acid value	23·11	27·97	29·57
Iodine value	105·6	50·5	103·01
Saponification value ..	236·3	239·2	205·82
Reichert Meissl value ..	33·63	14·76	26·64
Unsaponifiable matter ..	....	....	8·355
Yield of the oil ..	35—40%	....	40—45%

* Proc. Ind. Sc. Congress, 1928.

Table II. gives constants for the mixed fatty acids.

TABLE II.

	Pet. Ether extracted oil.	Ghani oil.
Neutralisation value	124·68	169·6
Mol. weight (M.W.)	320·8	235·8
Iodine value	352·5	50·6
Titre test	36·6°C	22·0°C
Refractive Index n_D at 40°C	1·4607	1·4473

Table III. gives constants for the saturated and unsaturated acids obtained from the mixed fatty acids from Ghani oil.

TABLE III.

	Saturated acids.	Unsaturated acids.
Molecular weight	252·04	280·7
Iodine value	1·95	77·2
Titre test	46·0°C	....
Refractive Index n_D ..	1·4328 at 60°C	1·4479 at 40°C

Further work on the oil is in progress.

203. Oil from Hibiscus cannabinis seeds.

S. Y. KOLHATKAR.

The following are the constants of the oil which is contained to the extent of 18·10 per cent. in the seeds.

Sp. gr. 0·9232; refractive index: 1·45916; acid value: 0·89; iodine value: 98·73; saponification value: 199·1; R.P. value: 0·20; Polenski value: 0·05; unsaponifiable matter: 1·04; acetyl value: 19·2; unsaturated acids: 76·66 per cent.; saturated acids: 23·34 per cent.

204. Oil from Tribulus Terristris fruits.

S. Y. KOLHATKAR.

The following are the constants of the oil.

Sp. gr.: 0·9241; refractive index: 1·46428; acid value: 1·32; iodine value: 141·05 (semi-drying oil); saponification value: 206·25; R.P. value: 0·25; Polenski value: 0·09; unsaponifiable matter: 1·2623 per cent.; acetyl value: 16·01; unsaturated acids: 86·60 per cent.; saturated acids: 12·40 per cent.

205. Investigations on the seeds of *Carica-papaya.*

N. DESIKACHAR *and* V. SAMPAT IYENGAR, Bangalore.

The seeds of *Carica-papaya* are used in medicine for various purposes. The present investigation forms a systematic chemical and biochemical analyses of the whole seed.

Successive extraction with the following solvents gave:—

Petroleum ether (40–50 B.P.)	=32·6 %
Chloroform	= 0·52%
Alcohol	= 0·86%

The petroleum ether extract gave a light yellowish green coloured oil which has the following constants:—

Sp. gravity (25°C.)	= 0·88
Refractive index (25°C.)	= 1·458
Iodine value (Hubles)	=304·0
Saponification value (1 hr.)	=234·7
Free acids	= 2·86

Detailed investigations are being carried out on the oil. The alcoholic extract gave tests for reducing and non-reducing sugars. Starch was absent in the alcohol extracted residue.

The seeds were further tested for the presence of different enzymes. The presence of amylase and lipase was distinctly shown, while traces of oxidase, peroxidase and catalase appeared to be present.

Further investigations on the presence of the above enzymes and proteases in germinated seeds are in hand.

206. Calamus.

N. C. KELKAR *and* B. SANJIVA RAO, Bangalore.

The oil obtained by distillation of the Indian root contains asarone (81 per cent.) terpenes (0·5 per cent.).

207. Study of tar from Cashew nut.

Y. K. RAGHUNATHA RAO.

The properties of tar from Cashew nut (Anacardium Occidentale) have been studied. The tar yields 35 per cent. distillate, a light yellow oil (B.P.200—300°C at atmospheric pressure) and density 0·89 at 25°C.

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Condensations of the distillate and of the tar with formaldehyde, acids, alkalies and oxidizing agents give light coloured or dark resins suitable for quick drying varnishes, impregnations and mouldings.

208. Studies in fish oils, Part I—Investigation of the factors involved in the technical preparation and storage of medicinal cod liver oil with respect to its vitamin potency.

K. D. GUHA, Bangalore.

Different batches of selected livers were 'cooked' in a small boiler (practically designed on the model of those used in the industry itself) with direct steam under different pressure to prepare the oil and the quality of the samples studied in relation to the conditions of livers, steam pressure, storage, refining, etc. An attempt has also been made to define the dietetic standard of cod-liver and certain other fish-liver oils.

209. The growth promoting factors in Indian dairy products.

N. C. DATTA *and* B. N. BANERJEE, Bangalore.

Very little is known regarding the growth promoting factors of Indian cow milk and its different products. Feeding experiment with Albino rats were used in determining the growth promoting factor.

The milk of a Scindi cow (yielding 17 lbs. of milk daily) kept at the Imperial Institute of Dairy and Animal Husbandry were used. The cow was on standard ration throughout the experiment. Butter and ghee were prepared from the milk of the same sample. By studying the growth of Albino rats with fresh milk and its products as a supplement to the basal diet, it was found that fresh milk was the best source of growth promoting factor. Milk sterilized at (15 lbs. for 15 mins.) suffered slight loss of this factor. The potency of butter and remelted butter were much less—nearly half that of fresh milk. Remelted butter (ghee) was found to be as good as butter.

The effect of cold storage on butter and ghee and further work on this line is in hand.

210. Stick-lacs: their composition and physical properties.

M. VENUGOPALAN *and* S. RANGANATHAN.

Stick-lacs of known origin have been collected from various parts of India, cleaned under the same conditions and the washed products analysed into wax, ether-soluble resin and alcohol-soluble resin. Softening and melting points, acid and iodine values were determined. Thin films prepared from these lacs have been tested for abrasion resistance and scratch hardness. On the strength of the above data certain tentative conclusions have been drawn as to their specific characteristics, in composition and physical properties, with a view to their classification on scientific lines.

211. Examination of some Calcutta pulses.

N. C. NAG *and* H. N. BANERJEE.

In a previous communication published in the *Proc. Sixteenth Ind. Sc. Congress*, composition of some common pulses was dealt with. That work has been further extended. In addition, the oils have been analysed, and different constituents determined. The usual constants such as iodine value, saponification number etc., have been dealt with. Of particular interest have been the absorption photo-spectrographs (visible range about 7,200 to 4,000 Å. units) obtained in various solvents. Carotinoid pigments have been detected particularly in the unsaponi-

fiable portion of the oils. Their connection with vitamines are being examined. Fuller details will be published later on. An abstract of results of chemical analysis in one particular case, viz., Cicer arietinum—chhola, is given below :—

Percentage of oil—4·2% ; Iodine value—130 (Hanus method)
Fatty acids in oil—90% ; Iodine value—140 ,,
Unsaponifiable matter in oil—1·5%, identified as Phytosterol, melting point 137°C.
Unsaturated liquid acid (Twitchel)—90% ; Iodine value—145 (Hanus)
Solid acid ,, —10% ; Iodine value—30 ,,

Separation of the constituents in the liquid unsaturated acid mixture was effected by preparing their bromo-derivatives and identified by estimation of bromine content as also the melting points of the derivatives.

Oleic acid—38·41% ; Linolic acid—59.36% ; Linolenic acid—2·23%.

212. The Chemistry of some west coast fish oils.

P. Ramaswami Ayyar, Bangalore.

A preliminary study of Mangalore 'Sardine' oil has been made and similar work on Embryonic 'Dog-Fish' liver oil and 'Shark' liver oil from Vaikom is in progress.

213. Sweating of soaps.

M. Goswami *and* K. L. Bose.

Anhydrous and hydrated soaps of lauric, myristic, palmitic, stearic and oleic acids have been examined individually and severally in proportions in which they are approximately present in commercial soap, as regards the absorption of moisture under standard conditions with and without inhibiting reagents.

214. Electrometric determination of the acid value and saponification value of resins.

N. Narasimha Murty.

A potentiometric method involving the use of quinhydrone electrode has been evolved for the determination of the acid value and saponification value of resins. 95 per cent. alcohol is used as the solvent ; and, for reference electrode, a saturated solution of lithium chloride in 95 per cent. alcohol with quinhydrone electrode is used. The acid value and saponification value of shellac, seed lac, wax-free lac, bleached lac, ether-soluble lac, ether-insoluble lac, rosin, pontinac, and sandarac have been determined by the new method. Standardisation of the alcoholic potash with alcoholic solution of benzoic acid is recommended instead of with the aqueous solution which gives higher value for the normality. On account of the obvious advantage which the quinhydrone electrode has over the hydrogen electrode, the method can be adopted in all industrial laboratories for the determination of acid value and saponification value of resins.

215. Studies in fish oils. Part II—A comparative study of the chemical composition of different kinds of marine and fresh-water fish oils in relation to their medicinal value.

K. D. Guha, Bangalore.

A quantitative method has been developed to determine percentage composition of the most complex mixture of fatty acids occurring in

fish oils. The liver oils of cod, hake, dog-fish, etc., and the body oil of the Indian sardine together with that of the sweet-water fishes, namely, ruhit, dhain, hilish, mrigel, etc., from Bengal have been investigated.

216. Investigation of the oil of *Clupea ilsha*.

M. GOSWAMI *and* JAGADANANDA DATTA.

The oil was rendered very easily from the fish which is abundantly found in Bengal and detailed examinations as regards the qualitative and quantitative values, constituents and Hilditch's ratio, etc., have been done.

217. Estimation of ψ-morphine in commercial morphine.

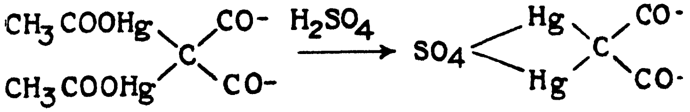
G. S. AHLUWALIA *and* J. N. RAY.

A quantitative method has been worked out for the above estimation based, on the insolubility of morphine sulphate in dilute alcohol.

218. Mercuration of compounds containing a reactive methylene ($-CH_2-$) group.

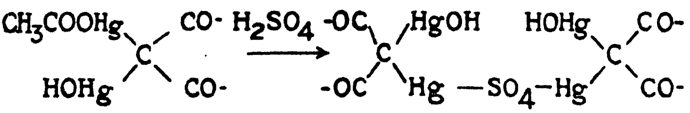
K. G. NAIK *and* R. P. PATEL, Baroda.

Mercuric acetate was employed to mercurate the following substances:—(1) acetoacetanilide, (2) acetoacet-o-toluidide, (3) acetoacet-p-toluidide, (4) acetoacet-m-toluidide, (5) acetoacet-α-napthylamide, (6) acetoacet-β-napthylamide, (7) acetoacet-1 : 3 : 4-xylidide, (8) acetoacet-1 : 4 : 5-xylidide, (9) acetoacetic ester, (10) acetoacet-m-nitranilide, (11) ethyl malonate, (12) malon-mono-phenylamide, (13) malon mono-o-toluidide, (14) malon mono-p-toluidide, (15) malon mono-m-toluidide, (16) malon mono-α-napthylamide, (17) malon mono-β-napthylamide, (18) malon mono-1 : 3 : 4-xylidide, (19) malon mono-1 : 4 : 5-xylidide and (20) malonamide. Compounds of the following two types were obtained. Whereas compounds 1–11 reacted with mercuric acetate in methyl alcohol giving diacetoxy-mercury derivatives of the formula (I)



(I)

compounds 12 to 20 reacted under similar conditions giving compounds of the constitution (II):—



(II)

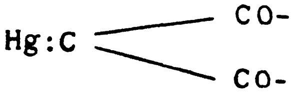
Compounds of type I gave sulphatomercury derivatives; while those of the type II gave hydroxysuphatomercury derivatives as shown above. Action of potassium iodide and sodium hydroxide supported the above constitution. From the action of dilute hydrochloric acid, hydrogen sulphide and potassium iodide, it appears that the linkage between the

carbon atom of the reactive methylene group and mercury, is a very weak one as is expected from compounds containing a mercury attached to a carbon atom in a position alpha to a carbonyl group.

219. Interaction of mercuric chloride with substances containing a reactive methylene group.

K. G. NAIK *and* R. P. PATEL, Baroda.

In previous work (*J.I.C.S.*, 1930, 7, 655) it was shown that equimolecular quantities of mercuric chloride and sodium bicarbonate react in the cold with compounds containing a reactive methylene group, giving dichloro derivatives. However, during the course of the reaction described here, sodium bicarbonate was taken in excess and the mixture heated, expecting that the hydrolysis would proceed to completion and the nascent mercuric oxide formed during the course of reaction, would react giving compounds with C Hg linkage The action of mercuric chloride has been studied with the following substances.—(1) malon monophenylamide, (2) malon mono o toluidide, (3) malon mono-m-toluidide, (4) malon mono-p-toluidide, (5) malon mono-α-napthylamide, (6) malon mono-β-napthylamide, (7) malon mono-1 3 4-xylidide, (8) malonamide, (9) ethylacetoacetate, (10) acetoacetanilide, (11) acetoacet-p-toluidide, (12) acetoacet o-toluidide, (13) ethyl malonate. Compounds of the following constitution were obtained.—



These compounds decomposed on treatment with dilute hydrochloric acid, hydrogen sulphide, potassium iodide and phenyl-hydrazine. These reactions indicate a weak carbon-mercury linkage as is always found, when the mercury atom is attached to a carbon atom, in a position alpha to a carbonyl group.

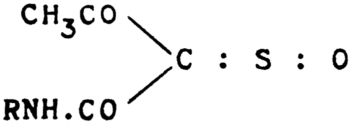
220. Interaction of thionyl chloride in *boiling benzene* with substances containing a reactive methylene ($-CH_2-$) group.

K. G. NAIK *and* V. B. THOSAR, Baroda.

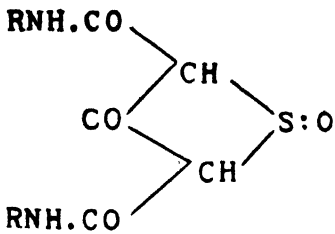
In continuation of previous work (*J.I.C.S.*, 1930, 7, 137, 145) the action of thionyl chloride in *boiling benzene* was further studied with the following compounds.

(1) Acetoacet-anilide, (2) acetoacet o-toluidide, (3) acetoacet-m-toluidide, (4) acetoacet p toluidide, (5) acetoacet-α-napthyl amide, (6) acetoacet-β-napthyl amide, (7) acetoacet-xylidide (1 : 3 : 4), (8) acetoacet-xylidide (1 : 4 : 5), (9) acetone-dicarboxy-anilide, (10) acetone-dicarboxy-o-toluidide, (11) acetone-dicarboxy-p-toluidide, (12) acetone-dicarboxy-α-napthyl amide, (13) acetone-dicarboxy-β-napthyl amide.

Amides (1) to (8) gave rise to sulphoxides of the general constitution,



whereas amides (9) to (13) gave sulphoxides of the type



As compared with the sulphoxides obtained from substituted amides of malonic acid these were stable in boiling benzene with excess of thionyl chloride or dry hydrochloric acid gas and towards moisture, inasmuch as they were neither degraded into sulphides nor decomposed by such treatment.

The results of the present investigations afford a clear evidence that the reactivity of thionyl chloride with compounds containing a reactive methylene ($-CH_2-$) group depends largely upon the electronegative character of the attached grouping.

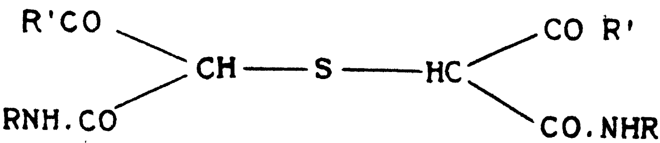
221. Interaction of thionyl chloride in the *cold* with substances containing a reactive methylene ($-CH_2-$) group.

K. G. NAIK *and* V. B. THOSAR, Baroda.

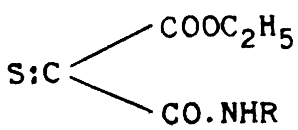
From literature it is evident that the course of reaction followed by thionyl chloride is entirely guided by the conditions of the experiments. Hence it was thought interesting to examine the course of reaction followed by thionyl chloride when it reacts with substances containing a reactive methylene ($-CH_2-$) group in *cold ethereal solution*, although a similar reaction in *boiling benzene solution* had resulted in the formation of sulphoxides. The following compounds were investigated.

(1) Acetoacet-anilide, (2) acetoacet-o-toluidide, (3) acetoacet-m-toluidide, (4) acetoacet-p-toluidide, (5) acetoacet-β-napthyl amide, (6) acetoacet-xylidide (1 : 3 : 4), (7) malon-di-n-propyl amide, (8) malon-di-iso-butyl amide, (9) ethylmalon-o-tolyl amate, (10) ethylmalon-p-tolyl amate, (11) ethylmalon-β-napthyl amate, (12) ethylmalon-xylil amate (1 : 3 : 4), (13) ethylmalon-xylil amate (1 : 4 : 5).

Compounds (1) to (8) gave compounds of the constitution,



while the amates (9) to (13) gave sulphides of the formula



All these compounds are white crystalline products, quite analogous in properties to the sulphide of acetoacetic ester described by Michaelis and Philips (*Ber.*, *23*, 559).

Section of Zoology.

President:—PROF. D. R. BHATTACHARYA, M.SC., PH.D., D.SC.

Presidential Address.

A REVIEW OF CYTOLOGICAL STUDIES IN GLANDULAR SECRETION.

Broadly speaking, the problem of secretion implies a group of phenomena in which materials of many kinds are elaborated in the cytoplasm, either to be returned to the cell-system, or to be extruded as a part of some secretion. Ranvier and Bowen preferred to restrict the term 'Secretion' to the process of intra-cellular synthesis and the term 'Excretion' to the process of extrusion or the emptying of a gland-cell. Johannes Muller pointed out that the whole process of secretion consisted of two phases—the production of certain materials, and the casting out of these materials upon a surface either in the interior or upon the exterior of the body. The first phase he called 'Secretion', and the second 'Excretion'. This distinction, however, is not quite in accord with the terminology maintained by physiologists. For all practical purposes, it will serve the purpose of cytologists.

The production of fluid or semifluid substances, in connection with definite glandular organs, has long been known and during the 18th century serious attempts were made to harmonise glandular phenomena with anatomical knowledge. With the emergence of the Cell-theory immediate efforts were made to reduce glandular structure to a cellular basis. To Theophile de Bordeu of Paris (1749), we are indebted for his having given us the idea of a glandular secretion into the blood system. That differences in the contents of gland-cells correspond to differences in the excretion products of glands was suggested by Henle in 1841, and the first clear proof that gland cells actually contain part of the excreted material was supplied by Goodsir in 1844, in the case of the ink of Cuttle fish. To Berthold (1849), belongs the honour of being the first experimental demonstrator who proved the reality of a gland with a true internal secretion and the power it exercised through the blood upon the entire organism. That the sebacious glands become laden with fatty secretory products which are lost at the time of excretion was described by Kolliker in 1850. To Claude Bernard (1855), we are indebted for having coined the terms 'Internal Secretion' and 'External Secretion'.

According to Swale Vincent, the process of internal secretion consists in the preparation and setting free of certain

substances of physiological utility (the raw materials for which are supplied by the circulatory system), by certain cells of a glandular type; the substances set free are not passed out on to a free surface but into the blood stream. According to Schäfer the term internally secreting or endocrine organ implies a structure which is known to form some specific chemical substance within its cells and to pass this directly or indirectly into the blood stream. It became clear after long controversy that gland-cells may evacuate their secreted contents in several different ways. Ranvier describes two extreme types of behaviour—'Holocrine' and 'Merocrine'. The simplest type is the holocrine gland, which has as a product the cells themselves with all their enclosed secretion. Such are, e.g., the sebacious glands of mammals, and avian oil-glands. In merocrine glands, on the other hand, the secretory products are released from the individual cells which themselves are left to repeat the process. According to R. Heidenhain (1868), all gland-cells would in the final analysis belong to the holocrine type. He held the view that gland-cells become filled with secreted material which is discharged together with the cell when the gland becomes active so that cell and secretion form the substratum of the glandular discharge. Pfluger (1866), on the other hand, held that the gland-cell produced secretions from which it freed itself at stated moments, returning then to its primitive condition to repeat the cycle of storage and discharge. In the controversy over this subject, Zoologists like Lavdovskey (1877), Van Gehuchten (1890), Galeotti (1895), Krause (1895), Kolossow (1898), and Oppel (1900) took part. It had finally to be admitted that the actual length of life of a given cell and the exact method of replacement are phenomena still imperfectly understood. Thus, our modern ideas regarding gland-cell gradually took shape. There is no doubt now that the gland-cell is in reality a secretory cell. In each and every case of secretory activity there is deposited in the cytoplasm of the gland-cell, a characteristic secretion-material, although the excretory process may be either of holocrine or merocrine type.

The real nature of secretion-process was first clearly elucidated by Altmann (1894), who proved the occurrence in the cytoplasm of discrete granules (or vacuoles) as a result of secretory activity. The morphology of the granules which are the essential products of secretion have been studied only lately and the literature has grown side by side with the advance made in our knowledge of cytoplasmic inclusions in cells. Bensley (1910), advanced the 'Vacuole' hypothesis of the Golgi Apparatus which according to Gatenby has priority over the same Guilliermond-Mangenot-Parat hypothesis. The Bensley prozymogen granule (vacuome) theory of pan-

creatic secretion proposed that zymogen granules are formed in vacuoles which appear in a definite region of the cell which stain in neutral red, and which come and go according to the state of secretory activity of the cell. Gatenby thinks that modern interpretations practically all now turn to the idea that in many cells zymogen appears as spaces or granules which are stained by neutral red and which are in many cases embraced by fragments of Golgi substance. The structure of each secretory droplet has been studied and interpreted by Renant (1911), Bowen (1926), and Parat (1928), in the following manner:—A vacuole first arises as a watery droplet separated from the rest of the cell-substance by a limiting surface-membrane of some kind. Across this membrane pass secretory materials which have been elaborated by cellular activity. Gradually these become concentrated within the vacuole and are finally deposited in the form of familiar 'Segregation granules'.

In regard to the physiological interpretation of the origin of secretions, two views have been advanced. According to one view, derived from Claude Bernard's theory of vital activity, the secretory droplets arise by a process of direct chemical transformation occurring in protoplasm. According to the other view, advanced by Pfluger, the gland-cell builds secretory materials through special synthetic activity and is then capable of getting rid of these products whenever necessary. As appears now, this is the only view in harmony with the morphological findings. The secretory activity of a gland is directly linked with activities of the cells themselves. In the beginning the cytoplasm of a gland-cell presents an appearance which is quite free from secretion droplets. These latter soon appear in characteristic ways in different glands and increasing in number and size give to each gland-cell its characteristic histological appearance. Finally, in the case of holocrine glands, the cell gorged with secretion is extruded bodily while in the case of merocrine glands its secreted contents are either partially or wholly expelled.

Regarding the origin of secretion droplets, divergent views have been expressed since Virchow and Heidenhain's time in 1875. Scores of conflicting cytological explanations of secretory synthesis have been advanced. A few of the most important ones may be mentioned here.

The part played by Nucleus in secretion.[1]

While some are disposed to think that the nuclear changes in size and position are circumstantial evidence of the part played by nucleus in secretion, others, notably Nussbaum

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[1] I am indebted to Bowen's series of papers for much valuable information that is incorporated in this paper.

held the view that these changes are brought about primarily by the compression of the nucleus due to accumulating secretory granules. In other words, the changes in appearance are more of mechanical origin and do not give an exact idea of the function of the nucleus in a gland-cell. In Invertebrate gland-cells the nuclear behaviour is often very remarkable particularly with respect to the shape of the nucleus and the power of stainability. In the spinning glands of insects, the nuclei are at first ovoidal, but subsequently become extraordinarily branched so that each extends itself throughout the cell. However, beyond the fact that the nucleus varies in size, being smaller in cells gorged with secretion, conspicuous differences in volume are very unusual. So far as Vertebrate tissues are concerned, the argument in favour of a direct synthesis is not particularly convincing. Among Invertebrates, superficially, the facts lead us to believe that nucleus and cytoplasm may in some way co-operate in secretory synthesis.

The origin of secretory droplets from the nucleus has been occasionally described. Galeotti (1895 and 1897) mentions the migration of small granules from the nucleus to the cytoplasm in various amphibian glands. Dehorne and Hosselet (1928), described 'nucleo-rouge' bodies which emerge from the nucleus in silk glands and are said to give rise to chondriosomes. The nucleolar component which is generally said to give rise to the materials of secretion is the true nucleoulus or plasmosome, of which one or more may occur in the nuclei of gland-cells. Ogata (1883) was the first to describe the emergence of the nucleoulus in pancreas cell. His work has been followed by those of others on more or less the same lines; e.g., Maziarski (1911), Nakahara (1917), Saguchi (1920), Noel and Paillot (1927). Definite conclusions as to the part played by the nucleus in glandular secretion are rendered doubtful by the fact that satisfactory accounts of the extrusion of nucleolar material through the nuclear membrane and their ultimate fate in the cytoplasm are not yet forthcoming. It has also been suggested that there is a possibility that the secretory granules may be given out by nuclear reticulum. Goldschmidt's chromidial hypothesis (1905) has been responsible for most of the work in this direction. This hypothesis has been examined, among others, by Kulmatycki (1922), who has come to the conclusion that chromidia are deformed mitochondria and are not derived from nucleolar extrusions. Jorgensen (1913), has likewise denied the extrusion of formed chromidia, and concludes that there is little evidence of the nucleus playing any definite part in secretory synthesis. Bowen (1929) thinks that the extrusion of nucleolar matter may be an established fact in gland-cells but it does not in any way throw new light on nucleo-cytoplasmic interchanges

for secretory activity. Thus a number of authors while admitting the validity of nucleolar extrusions, have denied that the material thus transferred to the cytoplasm has any visible connection with secretion. On the contrary, the extruded nucleoli seem to break up and are in many cases lost in the general cytoplasm. In the end the argument in favour of nuclear participation in secretion falls back upon indirect evidence such as that advanced by Korschelt in 1889. In general, the opinions held do not warrant a belief that nucleus is the immediate source of secretions.

The part played by Cytoplasm in secretion.

According to Altmann (1894) a secretory droplet arises by the mere growth of a granule or bioplast, which eventually achieves the transformation chemically necessary for a particular secretion. This view has been developed by M. Heidenhain (1907), who derives secretory granules directly from the ultimate submicroscopic, living particles or 'protomeres' out of which he considers protoplasm to be constructed. The 'ergastoplasm' of certain earlier workers may be defined as a substance of basophilic nature situated close to the base of a gland-cell and connected in some way or other with the elaboration of secretory products. The development of chondriosome theory dealt the idea of ergastoplasm a very serious blow and it was suggested by several workers that the ergastoplasm meant nothing but poorly fixed chondriosomes.

In accordance with Meves' theory, it was expected that chondriosomes would yield secretory granules. As a matter of fact, the granules and 'vegetative fibres' from which Altmann had derived secretory granules, were actually proved to be chondriosomes. According to one view [Schultze (1911). and Arnold (1912)] the chondriosomes in gland-cells were believed to fragment and the granules thus derived underwent metamorphosis into definitive secretory droplets. According to the second view (Regaud, 1909–1911), the chondriosomes themselves do not become secretory granules but act merely as selecting bodies or plasts in or on which the secretory materials are deposited. According to the third view (Saguchi–1920, Kull–1925, Morelle–1927, Tschassownikow–1927, Urasov–1928), the chondriosomes fragment, the granules thus formed are subsequently modified by some action of the Golgi apparatus, ultimately giving rise to secretory droplets. Morelle (1925) advances a peculiar conception that in pancreatic cells the Golgi apparatus is in reality a unique substance forming in the protoplasm a sort of 'tache homogene' or the 'secretogenous area' of Saguchi. The chondriocontes penetrate this area and furnish the material for the production of granules.

Saguchi, however, denies the existence of filamentar chondriosomes in this area. The whole problem has been reviewed extensively by Duesburg (1912), and Cowdry (1918). The latest works of Bowen (1926), Jacobs (1928), and Parat (1928), make it increasingly clear that the part the chondriosomes may play in secretory synthesis can only be largely invisible and indirect. At present there is no proof that chondriosomes play any direct part in secretion.

The possibility that the Golgi apparatus might play some part in secretion has been suggested from the very beginning of serious study of this structure. Holmgren (1902), and Prenant (1905) first initiated the idea, though vaguely. The recent development of the subject is due to improvements in osmic techniques which offer a simultaneous and almost perfect demonstration of the Golgi material itself and the secretory products. Such preparations of vertebrate gland-cells were obtained by Nassonov, whose contribution in 1923, foreshadowed by the works of Deineka and Kolatchev in 1916, marks the beginning of recent views on the subject.

In animal cells, the Golgi apparatus occurs in the cytoplasm of gland-cells in two morphologically different forms. In one case, the material forms a unit structure of tangled meshwork. In the other case, the Golgi material lies in the form of discrete pieces or 'bodies'. There are many intervening grades between these two extreme types. The point to bear in mind is, that the mere morphology of the Golgi apparatus is of no consequence, it is the substance itself on which there has been a difference of opinion. As a rule, the Golgi apparatus in gland-cells presents a rather marked polarisation. It is concentrated in the zone between the nucleus and the surface of the cell where the secretory products are extruded. In the earlier phases of secretory cycle, the secretory granules lie within the Golgi network area, where they are easily distinguishable as yellowish spheres or as red granules after staining with acid fuchsin. *Pari passu* with the production of granules the Golgi area becomes filled with secretory materials. Eventually, the granules move away and collect in the area of the cell next to the glandular lumen. This fact points to the idea that a very close topographical relationship exists between the Golgi material on one hand and the secretory products on the other. Ludford considers it possible that droplets of secretion may be formed within the substances of the Golgi apparatus, or that osmophil fragments may be broken off from the apparatus, and that these then may become converted into the granules, which are then discharged as droplets of secretion. Certain important points as emphasised by Bowen may now be mentioned. In the first place, during the secretory cycle the Golgi apparatus undergoes a marked hypertrophy. In the second place, it is

indirectly significant that the Golgi material itself is not visibly used up during secretory activity; in other words, it does not itself seem to be transformed into secretory granules. In the third place, with respect to the ultimate origin of the secretory droplets there are several possibilities. For example, the original granules might be derived from the fragmentation products of mitochondria or from some ultimate protoplasmic particles. This material is supposed to be worked upon by the Golgi apparatus. Bowen has come to the conclusion that the weight of evidence is in favour of viewing the earliest secretory vacuoles as structures not to be traced to any direct morphological relation with cellular structures previously present in the cell.

The general topographical relationship of Golgi apparatus with secretory granules having been established, the problem resolves itself into finding the exact relation of individual secretory granules to the Golgi bodies. Morphological appearances suggest that the secretory vacuoles arise *de novo* within or on the surface of Golgi material and remain in close relationship with the Golgi apparatus during their development. Ludford (1925), in the sebaceous glands of mouse, and Bowen (1926), in the oil-gland of fowl, observed that the fragments of the Golgi apparatus are characteristically associated with individual secretory droplets. In these cases each granule appears to be associated with a small piece of Golgi material.

The recent works of Benoit (1926), Hirschler and Hirschlerowa (1928), and Parat and his colleagues (1928), have shed further light upon the problem of secretory beginnings. Parat demonstrated stages in secretory synthesis by intravital methods. By means of neutral red technique he brought the smallest droplets or vacuoles clearly into view and studied the whole story of their transformation into secretory droplets. It became clear that the vacuoles arise in the Golgi area probably through its activity and thus furnish a constant supply of new secretory vacuoles. These earliest stages of secretory synthesis constitute the 'vacuome' of Parat. Within each vacuole appears the segregation granule which does not usually take the neutral red stain but can be demonstrated after fixation by acid fuchsin. As the secretory droplet grows in size its capacity for taking in the neutral red stain gradually disappears because the segregation granule fills up the entire space. The nature of the physiological relation existing between the Golgi material on one hand and the contents of a secretory vacuole on the other, still remains a problem on which no direct evidence is yet forthcoming.

The conclusion, generally arrived at, is that the immediate source of secretory synthesis lies in the area occupied by the Golgi apparatus and from this point of view the Golgi

apparatus may be said to manufacture the secretory droplets. The majority of workers on gland-cells like Nassonov, Bowen, Gatenby, Ludford, Hirschler, etc., support this view whereas Benoit, Parat (in certain respects), Beams, and Wu find this conclusion untenable. Kopsch and Urasov, on the other hand, find evidence still inconclusive. The subject, therefore, still affords a valuable field for further investigations, and I doubt not that workers in India will tackle this problem in the near future.

SELECTED REFERENCES.

1. BEAMS, H. W., *and* WU, C. F. Cytological studies on the spinning glands of *Platyphylax designatus*. (*Journal Morpho. and Phys.*, 47, 1929).

2. BERMAN ... ... The Glands regulating Personality (*Macmillan and Co.*).

3. BOWEN, R. H. ... ... Studies on the Golgi Apparatus in Gland Cells.
I. Glands associated with Alimentary Tract. (*Q.J.M.S.*, Vol. 70, Jan. 1926).

4. *Ibid.* ... ... Studies on the Golgi Apparatus in Gland Cells.
II. Glands producing Lipoidal secretions. (*Q.J.M.S.*, Vol. 70, April 1926).

5. *Ibid.* ... ... Studies on the Golgi Apparatus in Gland Cells.
III. Lachrymal Glands and Glands of the Male Reproductive System. (*Q.J.M.S.*, Vol. 70, Sepr. 1926).

6. *Ibid.* ... ... The Cytology of Glandular Secretion. (*Quarterly Review of Biology*, Vol. IV, Dec. 1929).

7. *Ibid.* ... ... The Origin of secretory granules. (*Proc. Nat. Acad. Sc.*, 9, 1923).

8. BRAMBELL, F. W. R. ... The part played by the Golgi apparatus in secretion. (*Jour. Roy. Mic. Soc.*, 1925).

9. CRAMER, W. *and* LUDFORD, R. J. On Cellular activity and Cellular Structure as studied in the Thyroid Gland. (*Jour. Physio.*, Vol. LXI, June 1926).

10. *Ibid.* ... ... On the Cellular mechanism of Bile Secretion and its relation to the Golgi Apparatus of the liver cell. (*Jour. Physio.*, Vol. LXII, Oct. 1926).

11. GATENBY, J. B. ... ... The Prozymogen granules ('vacuome') of R. R. Bensley in the *Pseudotriton* pancreas, and the modern neutral-red Cytology. (*Am. Jour. Anat.*, Vol. 48, July 1931).

12. LUDFORD, R. J. ... ... Cell Organs during Secretion in the Epididymis. (*Proc. Roy. Society B.*, Vol. 98, 1925).

13. LUDFORD, R. J. ... ... Nuclear Activity during Melanosis with Special Reference to Melanin Formation in a Melanotic Sarcoma. (*Jour. Roy. Micr. Soc.*, Dec. 1923).

14. LUDFORD, R. J., *and* CRAMER, W. Secretion and the Golgi Apparatus in the cells of the Islets of Langerhans. (*Proc. Roy. Soc. B.*, Vol. 101, 1927).

15. *Ibid.* ... ... The Mechanism of Secretion in the Thyroid Gland. (*Proc. Roy. Soc. B.*, Vol. 104, 1928).

16. MORELLE, J. ... ... Les constituents du cytoplasme dans le pancreas et leur intervention dans le phenomene de secretion. (*Extrait du volume jubilaire V. Gregoire, 3 epartie,* '*La Cellule*', Vol. XXXVII, Novembre 1925).

17. PAPPENHEIMER, A. M. ... The Golgi Apparatus. Personal Observations and a Review of the Literature. (*The Anatomical Record*, Vol. II, November 1916).

18. PARAT, M. ... ... Contribution a l'etude morphologique et physiologique du cytoplasme. (*Archives d'Anatomie Microscopique*), Tome XXIV, 1928.

19. SAGUCHI, S. ... ... Studies on the glandular cells of the frog's pancreas. (*Am. Jour. Anat.*, 26, 1920).

20. SCHÄFER, E. A. ... ... The Endocrine Organs. (*Longmans, Green and Co.*, 1916).

21. STARLING, E. H. ... ... The Fluids of the Body. (*Archibald Constable and Co., Ltd.*, 1909).

22. VINCENT, SWALE ... ... Internal Secretion and the Ductless Glands. (*Edward Arnold*, 1912).

Section of Zoology.

Abstracts.

1. On the nature and identification of some small Trichomonads from the intestine of Termites hitherto related to the so-called *Trimitus* stages of Duboscq and Grassé.

I. Froilano de Mello, Nova Gôa.

Small flagellates found in termites by Duboscq and Grassé and described by these authors as *Trimitus* forms, which they consider as evolutive stages of *Devescovina*, *Janickiella* and *Trichomonas* have been studied by Kirby Jr. as belonging to a new genus *Tricercomitus*, the hypothesis of the French authors concerning this so-called evolution having been rejected by Kirby. In the intestine of the Indian termite *Coptotermes heimi* Wasin, there is a rich fauna of *Devescovina*, *Colonympha* and these so-called *Trimitus* forms. The author studies such forms in detail, identifies them to the genus *Tricercomitus*, species *divergens* Kirby Jr. and rejects also the hypothesis of such flagellates belonging to the evolution of the genus *Devescovina*.

2. On a collection of sponges from Karachi.

Anand Kumar *and* Sukh Dyal.

A large collection of sponges was made some time ago by us and our research students from Karachi. The paper gives an account of several species belonging to the subfamily Renerinae, Gellinae, Phloeodictyinae, Esperellinae, Axinellinae, Ectyoninae, and the section Cymonae, along with some sponges in Suberitina.

3. Further observations on *Limnocnida indica* Annandale.

H. Srinivasa Rao, Calcutta.

The occurrence of freshwater medusae in India was first recorded by Annandale in 1911 (*Nature*, p. 114). Since then several observations have been made on them on various occasions by Agharkar, Gravely, and Annandale in the valleys of the Kistna, Koyna, and Yenna rivers in the Satara district of Bombay. But the life-history of the medusae has been more or less obscure. In the present note the author gives the results of his observations on these medusae at various localities on those rivers, and offers a few remarks on the distribution of the Indian and African representatives of the genus, and on the origin of the medusae in India based on the available geological evidence. The hitherto general belief that there should be an asexual hydroid phase in the life-history of the medusae is abandoned, and the view is put forward that the Indian medusae reproduce only sexually during the dry season, and deposit eggs which rest at the bottom of deep pools in the course of these rivers, anchored to particles of mineral or vegetable debris by sticky threads which are given off from the surface of the eggs on contact with foreign bodies. Throughout the monsoon when the rivers are in flood the eggs presumably lie dormant, but begin to develop at the end of the cold weather directly into medusae which generally do not rise to the surface of the pools until summer has set in.

4. Hydromedusae of Madras.

M. G. K. MENON, Madras.

The paper is a systematic account of the Hydromedusae obtained from the plankton of the Madras Coast, during 1929–31. The collection contains 35 species belonging to 28 genera, of which one genus and six species are new to science. The majority of the forms, however, belong to the Leptolinae, as is only to be expected from such a littoral collection. The few species of Trachylinae were obtained at irregular intervals unlike the former which showed definite periods of occurrence and seasonal abundance. It is presumed from these facts that the typical oceanic medusae are only occasional visitors to the coast brought by currents or strong wind. The present study has also shown that there is a tendency for the littoral forms of this coast to preponderate in the plankton, both in bulk and in species, during the colder months of the year, which succeed the monsoon rains. Geographically, the collection adds to our knowledge of the Hydromedusae of the Indo-Pacific. There is a general similarity to other littoral collections made from this region. Some of the Atlantic and Pacific medusae are recorded for the first time from the Indian Ocean.

5. On the genus *Pocillopora* from the Great Barrier Reef of Australia.

G. MATTHAI, Lahore.

Four species of *Pocillopora*, viz., *P. damicornis*, *P. danae*, *P. verrucosa* and *P. eydouxi* are represented in the collection of corals made by the scientific expedition to the Great Barrier Reef of Australia. The growth form and relationships of the species of this remarkable genus of corals are discussed in the paper.

6. New Monostomes of the family Pronocephalidae with a classification of the family.

H. R. MEHRA, Allahabad.

Diaschistorchis gastricus n. sp. described is found in the stomach of freshwater tortoises at Allahabad. The only other species of the genus, i.e., *D. pandus* (Braun) is parasitic in the marine tortoises, *Chelone mydas* of the Mediterranean sea, *Chelone imbricata* of the Queensland coast (Australia) and *Caretta caretta* of the Gulf of Mexico and Tortugas (West Indies).

The two new species of the new genus *Neopronocephalus* are described. This genus is distinguished from all the other genera by the position of its testes, which are situated symmetrically one on each side in front of the ovary.

While I have given a classification of the family Pronocephalidae in a paper, which is in course of publication in *Annals de Parasitologie*, a paper has been published by Price in which he has classified this family. It is a strange coincidence that his classification is based essentially on the same principle as mine, i.e., the position of the testes and that his two subfamilies are precisely the same as mine, i.e., the Pronocephalinae and Charaxicephalinae. But we disagree about the position of the genus *Diaschistorchis*. I have no doubt that this genus belongs to the Charaxicephalinae instead of the Pronocephalinae, in which Price has placed it. I accept the subfamily Opisthoporinae, Price for the genus *Opisthoporus*. Two new subfamilies, i.e., Neopronocephalinae mihi and Hippocrepinae mihi are created and their diagnosis given. The interrelationships of the subfamilies are discussed. The families Pronocephalidae and Notocotylidae are so closely related that it is a point worth

consideration whether they should be retained as separate families or merged into one family.

Keys to the subfamilies of the Pronocephalidae and to the genera of the subfamilies Pronocephalinae and Charaxicephalinae are given.

7. Acanthocephala from Northern India. II. A new species of *Centrorhynchus* from a Himalayan bird *Urocissa melanocephala occipitalis* (Blyth).

M. N. DATTA, Calcutta.

A new species of Acanthocephalan parasite found invariably infecting the digestive tract of the Himalayan bird, *Urocissa melanocephala occipitalis* (Blyth), is described under the name of *Centrorhynchus maryasis* n. sp.

A short account of the anatomical features characteristic of the genus and the new species is given in the paper. Full descriptions of the proboscis, proboscis hooks, proboscis sheath, nervous system, male and female genitalia and ova are also included.

In comparing with other known species of the genus, e.g., *C. austurinus*, *C. pinguis*, *C. aluconis*, *C. spinosus*, it was found that all of them resemble the new species *C. maryasis* in the shape of the body, in the attachment of the proboscis sheath near the middle of the proboscis and in the situation of the central nervous system near the middle of the sheath. The testis of *C. maryasis* is oval and the two testes lie closely opposed to each other. The prostatic glands, as in all species, are long and cylindrical. A strong sphincter muscle is developed in the vaginal wall. The new species differs from all other species of the genus in having a comparatively long and broad body in both the male and the female specimens; and in the number of longitudinal rows of hooks and of the hooks in each row. These characters were found to be constant in the new species.

8. The ecology of Polychaetes of Karachi.

NAJMUD-DIN AZIZ.

The author deals with the ecology of the common littoral Polychaetes met with on the sandy beach of Kiamari, on the rocky ledge of Manora and around Cyster Islands. He gives an account of the effects of tidal rhythms on these worms, mode of locomotion, power of regeneration, food, tube formation and other means of adaptation to environment. The colouration of these worms is also discussed.

9. Some abnormalities in the Indian leech—*Hirudinaria granulosa*.

M. L. BHATIA, Lucknow.

1. *Eyes.*—The normal number of eyes in this species is 5 pairs. They are metamerically disposed in segments 2, 3, 4, 5 and 6, a pair being present in each segment.

Eyes both in number and arrangement are of great diagnostic value. The full number of eyes may not always be present. Specimens have been collected at different times with one, two or even three eyes less.

2. *Posterior Sucker.*—Specimens were collected which were devoid of the posterior sucker. It is evidently accidental. These were kept under observation. The anterior sucker is more strongly developed and very well compensates for the absence of the posterior sucker. The anal aperture in such specimens is placed at the posterior extremity.

3. *Crop.*—The crop which extends over somites IX to XIX consists of a metameric series of axial chambers separated by intersegmental

constrictions. Each chamber bears a single pair of caeca. These caeca begin in segment X. The pregenital pairs are usually smaller and irregular. The post-genital caeca are fully developed and reach the segment next to it.

The posterior ends of caeca in the posterior genital region get fused with the axial chamber, thus forming a more spacious system for storing blood.

10. The ecology of the Entomostraca of Lahore.

G. L. ARORA.

In this paper the author discusses the effects of light and temperature on the water-fleas of Lahore, their capacity for resisting adverse conditions, phenomenon of moulting, modes of locomotion, etc.

11. A study of ant-behaviour.

SHER AHMAD.

The paper deals with the ants of Lahore. *Myrmecocystus setipes and Holcomyrmex scabriceps* preferably build nests in dry places. All species of *Phidole*, *Camponotus mitis*, *C. confucii* generally haunt sides of water drains. *Prenolepis indicum*, *P. longicornis*, *Tapinoma melanocephalum*, *Phidole latinoda*, *Polyrachis simplex Bothriomyrmex wroughtoni*, *Plagiolepis exigua* always build nests amidst roots of herbs and bushes. Species of *Cremastogaster* infest hollows and galls of trees. Other ants nest in damp places. The higher ants such as *M. setipes*, *H. scabriceps*, *Phidole indica*, *Camponotus compressus* build spacious galleries.

Most ants of Lahore hibernate in winter, resuming normal activities in March.

Nuptial flights of *H. scabriceps*, *M. setipes*, *B. wroughtoni* were observed in winter, and of the remaining species in the rainy season. In all species males linger in nests after nuptial flights. In *B. wroughtoni* and *Prenolepis indicum* nuptial flight occurred twice a year. Towards the end of March queens of *C. compressus* left old populous nests and founded new ones.

Experiments showed that the sense of smell in ants is not highly developed.

12. Nests of ants.

D. D. MUKERJI, Calcutta.

The architecture of the carton nests of the ants of the genera *Myrmicaria* and *Polyrachis* is described. These nests differ from those already on record from India and Burma. The bearing of the ecological conditions on the nesting habit of the ants is also considered.

13. On the occurrence of symbionts in a wood-boring insect *Rhabdophaga saliciperda* Duf. (Cecidomyiidae: Diptera) from English willow, with reference to the importance of micro-organisms in the control of pests.

PURNENDU SEN, Calcutta.

The genus *Rhabdophaga* (to which the insect *R. saliciperda* under discussion in this paper belongs) is of wide distribution in Europe and America. The insects of this genus are pests on the willows which are used in the manufacture of cricket bats and their importance in this branch of national industry is discussed. As the Cecidomyiidae are long known pests of the willows, the study of this group of insects is emphasised. The food habits of the gall midges (Cecidomyiidae) with special reference

to this species have been dealt with. The presence of symbionts has been recorded in the species in common with all wood-boring insects. Extensive experiments carried on for this purpose show that two kinds of micro-organisms, a fungus and a bacterium, are associated with this insect. The fungus was noted from outside the larva while the bacteria were from inside the gut. Uvarov's theory of controlling the pests by controlling the micro-organisms is criticised.

14. A note on the alimentary canal of some South Indian crickets.

T. K. GOPALACHARI, Cocanada.

This note deals with a comparative account of the alimentary canal of three South Indian crickets, the mole cricket, the house cricket and the field cricket. The alimentary canal of the mole cricket shows primitive features in the long oesophagus with a dorsal pouch, in the absence of a crop, the simple gizzard, and the rudimentary hepatic caeca. The other crickets show a more highly evolved alimentary system. The alimentary canal of crickets in general is much less evolved than that of the cockroaches and grasshoppers.

15. A new genus and species of Thrips from South India.

T. V. RAMAKRISHNA AYYAR, Madras.

Since the publication of his memoir on India Thysanoptera prepared in 1927 and of a recently prepared supplementary paper on the same subject, the writer has come across a very interesting thysanopteron which appears to be not only a new species but exhibits characters which have not been noted in any of the genera known to the writer. The insect belongs to the Tubuliferous section of the order and the extraordinary and the strongly developed fore legs appear to be unique in this creature. It is apparently new and is here described as a new genus under the name '*Veerabahu thrips*'—(Sanskrit—thrips with powerful hands).

The chief distinguishing features of this genus are the elongated body with the head narrow and more than twice as long as broad. The antennae are 8-jointed. The eyes are large and elongated and the ocelli distinct. The cheek behind the eye on each side is abruptly constricted and beyond this constriction the cheeks run more or less parallel to meet the prothorax. The most important generic feature is the unusual armature of the fore-limbs which are very stout and strongly armed. The femur is long and as broad as the head with four conspicuous teeth at its inner margin towards the apex, the tibia also possesses four teeth but of smaller size and in addition the tarsus is armed with a stout curved tooth at its base. In the resting posture of this insect these fore limbs have the femoral teeth interlocked with the tibial and tarsal teeth and look more or less as in the pedipalpi of some crabs. The insect has the usual two pairs of wings and other ordinary features of thrips. In this paper the generic and specific characters are described with some remarks on the possible affinities of the insect with previously known forms. The type is described as a new species under the name *V. bambusae*.

Specimens were found inside tender leaves of bamboo in company with some scale insects on the Coimbatore farm. It looks also probable that this insect is predacious on the bamboo thrips; but this has not yet been confirmed.

16. Notes on variation in the specific characters of spiders.

F. H. GRAVELY, Madras.

Different species of spiders commonly show a basic colour pattern which is constant, but subject to such modifications in the extent and

intensity of its darker and lighter parts as in some cases completely to obscure its nature unless a large series of specimens is available for comparison. The structure of the vulva is usually much more reliable, but in some common and widespread species this also varies greatly. In some cases these variations seem to be more or less closely associated with locality or with the age of the spider or both. These facts need to be carefully borne in mind when describing new species.

17. A note on the occurrence of a style sac and crystalline style sac in some more S. Indian Gastropods.

R. V. SESHAIYA, Annamalai Nagar.

The presence of a style sac and a crystalline style in some of the genera of Melaniidae, Hydrobiidae and Cerithiidae was discussed by the author at some of the sessions of the Science Congress. The present note deals with the occurrence of a style in *Assiminea* (*Family Assiminidae*) and in *Potamides* (*Cerithidea*) *obtusum* (*Lam.*) and in *Potamides* (*Telescopium*) *telescopium* (*Linn.*) in which a style and a style sac have not been recorded till now.

18. The anatomy of *Rachisellus punctatus* (Anton).

R. V. SESHAIYA, Annamalai Nagar.

The paper deals with the anatomy of *Rachisellus punctatus* (Anton), a small Pulmonate Mollusc, partly arboreal in habits. The genus *Rachisellus* was first established in 1889 by Bourguignat. Dr. Thiele classified it as a sub-genus of *Ena*, basing his conclusions on certain features of the radula. Gude considered the Achatinoid aspect of the shell of *Rachisellus* a sufficient case for its retention as an independent genus and followed the lead of Bourguignat.

The study of the anatomy shows among other things that the structure of the reproductive system of *Rachisellus punctatus* (Anton) does not lend any support to Dr. Thiele's view.

19. A comparative study of the nervous system of the Streptoneurous Gastropods of Karachi and Lahore.

N. A. JANJUA.

The nervous system of 12 species of the genera *Turbo*, *Paludina* (*Vivapara*), *Cypraea*, *Ranella*, *Conus*, *Cerithium*, *Nassa*, *Ricinula* and *Purpura* has been investigated.

The data obtained show that the nervous system has evolved from the primitive arrangement in which the ganglia are connected by long nerve strands, to the specialised condition in which all ganglia are concentrated around the oesophagus.

Hypoathroid, Dystenoid and Epiathroid types of nervous system with either Zygoneury or Dialyneury or both are seen.

20. A comparative study of the Radulae of the Streptoneurous Gastropods of Karachi and Lahore.

N. A. JANJUA.

As a result of the study of 10 species of Gastropods it is seen that the multicuspid teeth have probably evolved from those in which the teeth have no cusps or very minute ones. In the series of forms investigated the number of teeth in each row decreases while the number of rows of teeth increases. The three sets of teeth in a row, i.e., centrals, laterals and marginals, are present in the lower forms, but in the higher forms the marginals are absent.

21. On the Hypobranchial artery of *Cirrhinus mrigala* (H. B.) and *Catla catla* (H. B.) with short notes on their heart and afferent and efferent branchial system.

B. K. MITRA *and* EKENDRANATH GHOSH, Calcutta.

The hypobranchial artery, already described in Selachii, Dipnoi and some Teleostei, was found in a Cyprinid fish, *Labio rohita* by P. Sen. It is now found in two other Cyprinid fish, *Cirrhinus mrigala* and *Catla catla*. In general, the origin and distribution of the hypobranchial artery is quite similar in all the three Cyprinid fishes examined. It arises by two trunks, each of which is again formed by union of two vessels arising from the second and third efferent branchial vessels of each side. The branches of the hypobranchial artery are somewhat different in these three animals. It not only supplies the heart but also the urohyal and pectoral muscles. Short notes on the heart and the afferent and efferent branchial system of vessels are also added.

22. On the anatomy of *Polynemus paradiseus* Linn. and *Eleutheronema tetradactylus* Shaw.

EKENDRANATH GHOSH, Calcutta.

Polynemus paradiseus Linn. *Skeleton.* There are 10 precaudal vertebrae; first three have flattened spinous processes and without parapophyses. The neural arch of the first vertebra is articulated with the centrum. The fourth and fifth vertebrae have separate parapophyses. The other precaudal vertebrae have the parapophyses joined by a cross bar. There are fifteen caudal vertebrae of which the first thirteen have anterior and posterior ventral processes. The skull shows distinct percoid facies. Nasals are cartilaginous. Vomers are fused. Basi- and orbitosphenoids are absent. No orbitals are seen. The supra-occipital meets the frontal. There is no jugal. The ectopterygoid is fused with the entopterygoid.

Anatomy.—There are eight pyloric coeca. The intestine presents a double curve. There is a club-shaped gall-bladder. The spleen is elongated. There is no air-bladder. Of the four afferent branchial vessels, the third and fourth arise together. Of the four efferent branchial vessels, first and second end in the cephalic circle and the last two unite to form a common trunk which opens at the origin of the dorsal aorta. The left posterior cardinal vein is absent. The outer gill arches are only provided with gill-rakers. The kidneys are fused in the middle line except in the extreme anterior end. The right posterior cardinal vein is placed in the middle line between the two kidneys.

Eleutheronema tetradactylus Shaw. *Skeleton.*—Of the 10 precaudal vertebrae, first three have flattened neural spines and very small parapophyses. The neural arch of the first vertebra is not fused with the centrum. The parapophyses of the seventh to tenth precaudal vertebrae are connected by a transverse bar. Of the 15 caudal vertebrae, the first fourteen are provided with anterior and posterior ventral processes. The skull is, in general, similar to that of the other animal.

Anatomy.—The tubular pyloric portion of the stomach has five pyloric coeca. Each coecum arises by a stout trunk which divides into numerous branches ending in five blind tubular sacs. The intestine has a double curve. The rectum is elongately fusiform. The gall bladder is large and fusiform. The spleen is narrow and elongated. There is no air bladder. The afferent branchial vessels are similar to those of the last animal, in origin. Of the four efferent branchial vessels, the last two end in a common trunk which open into the dorsal aorta at a little distance behind its origin. The left posterior cardinal vein is absent. The outer gill axis is provided with gill-rakers like the last animal. The kidneys are fused in the middle line except in the extreme front. Renal arteries of two sides arise by a common trunk.

23. Further observations on the air-breathing habit in an Estuarine Gobiid.

B. K. DAS, Calcutta.

In 1930 the author gave a preliminary account of the peculiar mode of breathing atmospheric air by an estuarine Gobiid, at the Indian Science Congress (Allahabad). In the present paper the author records further observations and describes the behaviour of the fish under different conditions of water and other factors, the time for asphyxiation, etc. The histological character of the opercular rim and the vascular supply are also dealt with.

24. The paratoid and caudal glands in certain ranid larvæ.

L. S. RAMASWAMI, Bangalore.

The larvæ of *Rana curtipes Perd.* and *Rhacophorus pleurostictus* Gunther. have been known to possess paratoid glands and the former, an additional gland on the back of the root of the tail. The adults do not have them. These glands resemble histologically the poison glands of *Bufo melanostictus* Schneid. None of the Bufonid larvae so far described are known to possess larval poison glands. The comparison is between the larvae of these Ranids and the adult *Bufo.* The occurrence of these structures as larval features in the one set of cases and as an adult characteristic in the other, can only be treated as an adaptive modification arising independently, due to the general habits of life assumed by the larvæ and the adult toads.

25. Studies on the sexual cycle of some Indian Lizards.

J. J. ASANA, Ahmedabad.

The material for these studies consists of gonads both male and female and other structures taken periodically, at an interval of a fortnight to a month throughout the year, from the bodies of *Uromastix hardwickii, Calotes versicolor* and *Sitana pomticeriana* as the representatives of the family Agamidae, and *Hemidactylus flaviviridis* and *Mabuia macularia* as representatives of the families Geckonidae and Scincidae respectively of our Indian lizards.

These studies are being carried out with a view to observing and recording the seasonal changes, both macroscopic and microscopic, in both types of gonads, male and female, and attempting to find out whether these variations could be correlated with changes in their environment and with their more or less differing ways of living, or these seasonal variations are merely racial characteristics. Secondly, in view of the fact that though there exists an obvious relationship between the phenomena of sexual urge and of the testicular activity there is a great deal of controversy concerning which of the testicular elements, interstitial cells or germinal tissue, wields this influence. An attempt is being made by the application of modern cytological technique to reach some certainty with regard to the testicular hormone secreted.

No detailed study has been so far carried out in reptiles beyond a piece of research on the interstitial cells in the testis of the Horned Toad, *Phrynosoma solare*, an American lizard by R. F. Blount.

We have previously recorded the breeding habits and seasonal variations in the gonads of *Calotes versicolor, Sitana* (Agamidae) and *Mabuia* of the family Scincidae closely follow *Calotes.* But *Uromastix* though it belongs to the same family Agamidae, shows considerable divergence. When its allies *Calotes* and *Sitana* and also *Mabuia* are hibernating with their gonads at their lowest stage of regression reduced to a size not more

than a millimetre or two, the gonads of *Uromastix* have embarked on their progressive cycle and show considerable growth and internal activity. In January, February and March when the gonads of *Calotes* and *Sitana* and also those of *Mabuia* are lying dormant or just aroused from winter sleep *Uromastix* is at its height of breeding season already laying eggs, its testis having reached its maximum average size of about 1·8 c.m. × ·8 c.m. by the end of February.

The breeding season, the progressive and regressive cycles in the gonads of *Hemidactylus* though it belongs to a family different from Agamidae closely follow those of *Uromastix* in its sexual cycle.

26. The anatomy of a snake's tongue.

C. P. GNANAMUTHU, Madura.

The forked, extensile tongue of Ophidia is tactile. The Hyoglossi—the principal muscles of the tongue—are nearly two and a half times as long as the head. The Genioglossus is well developed and has its chief insertion very near the middle of the long Hyoglossi. The Genioglossus draws forwards the Hyoglossi to nearly a third of its length. The hyoid apparatus consists of two long stiff cartilaginous rods from the ends of which the Hyoglossi arise. When the Hyoglossi are drawn forward these are so bent that their recoiling retracts the Hyoglossi to their former position.

The intrinsic muscles of the tongue, Lateralis, Transversalis and Verticalis linguae appear in and round the Hyoglossi only in front of the insertion of the Genioglossus—where the Hyoglossi form the protrusible part of the tongue. The Hyoglossi extend to the extreme tips and serve to shorten or twist the tongue to either side. The lateralis and transversalis are responsible for the approximation and divarication of the tips, while the verticalis raises or lowers the sides of the tongue. Through a combined action of these muscles the tongue tips are moved in all directions.

27. On the genetic relationships of Ophidian families.

B. C. MAHENDRA, Agra.

The author has made a careful study of all the skeletal characters and some features of lepidosis of the Ophidian families and he criticises the genealogical tree of the Ophidia given by Boulenger in his *Catalogue of the Snakes in the British Museum*. The latter leaves the Typhlopidae and the Glauconiidae out of consideration 'as degraded burrowing types independently derived from some Ophidian form less specialised than any with which we are at present acquainted', and claims for the family *Boidae*, and more especially for the Pythons, 'the position of ancestral group from which all other Ophidia may have been derived'. He regards the Uropeltidae as distinctly higher than the Boidae and as having no particular affinities to the Typhlopidae and the Glauconiidae.

The present studies, however, show that the Uropeltidae is more closely allied to the Typhlopidae and the Glauconiidae than to any other family, and that the Boidae is genetically much higher than any one of these. In this connexion the importance of the two types of Ophidian ocular shields are pointed out and the possible course of their evolution indicated.

It is also shown that the Ophidia fall into two distinct groups, one genetically higher than the other. The first group consists of Typhlopidae, Glauconiidae, Uropeltidae, Ilysiidae, and Xenopeltidae: all those forms in which the cranial bones are more or less solidly united, the gape of the mouth is not very considerable and the two sides of the jaws cannot work independently to the same extent as in the higher forms. The second group comprises all the higher families in which the maxillaries, palatines and pterygoids move on each other.

In the end a tentative scheme of evolution of the lower snake families is given, and the important references on the subject mentioned.

28. The primitive nature of the alimentary canal of *Emyda vittata* Peters, with a note on the structure of the oviduct.

A. Narayana Rao, Bangalore.

The presence of a typhlosole in the intestine is a distinctly primitive character. Though from an examination of the Coprolites, it has been surmised by Lydekker that certain extinct reptiles, *Icthyosaurus*, possessed a structure similar to the spiral valve of the Elasmobranchs, so far as is known to the author, the alimentary canal of no living reptile possesses this structure. In *Emyda vittata* there is an extraordinarily well developed typhlosole extending practically from one end of the intestine to the other. In certain regions the typhlosole seems nearly to touch the wall of the intestine, reducing the intestinal cavity into a semilunar slit. The alimentary canal is extraordinarily long in this species.

Emyda vittata which is a common local species and is thoroughly aquatic ejects, as is well known, through the vent large quantities of water when taken out of its habitat. The general presumption is that this is not urine.

The structure of the oviduct is examined and commented upon in this connection.

29. Congenital absence of limbs in tortoises of the genera *Trionyx* and *Emyda*.

S. K. Dutta, Allahabad.

A deviation from the normal growth of the paired limb occurs now and again throughout the Vertebrate series and a brief account of the previous works on the limb abnormalities in Vertebrates is given in the paper. So far as the tortoises are concerned, no record of the absence of limb seems to be extant and the writer takes the opportunity of describing two such cases of anomalipeds. At the spot where the limb in question should have existed there was no indication of a scar and the internal structure also showed the defect to be due to developmental arrest instead of to an accident.

30. Two rare doves of the district of 24-Perganas.

S. C. Law, Calcutta.

1. *Œnopopelia t. tranquebarica* Herm. Its circumscribed range in the District. A resident bird: its occurrence not as uncommon in riparian tracts as in inland areas. Juvenile characters fully described.
2. *Streptopelia d. decaocto* Friv. Localised area of distribution of the bird. Haunts and habits described. Observations on juvenile plumage.

31. On *Goecichla citrina* Lath. breeding in the suburbs of Calcutta.

S. C. Law, Calcutta.

Discovery of a nest with three partially fledged young of the Orange-headed Ground Thrush near Baraset (District 24-Perganas), 15 miles from Calcutta. A second breeding pair observed near Gobardanga (24-Perganas). Status of the species discussed. Its generic traits and movements in the wake of migration. Tendency among individuals to cling to plains habitat in summer for nesting and thus form a non-migratory local race. Has this local domicile any effect on the resident individuals?

32. Place of *Munia oryzivora* (L.) in India's Bird fauna.

S. C. LAW, Calcutta.

Its original status—an exotic form introducing itself into different parts of India by escaping from the cage. Its rapid multiplication noted half a century ago. Mr. Stuart Baker's edition of F.B.I. (Birds) has, curiously enough, no reference to the species. A considerable colony observed recently near Calcutta (10 miles to its north): its feeding and roosting places described. No published record of its occurrence in Bengal.

33. Distribution of *Sauropatis chloris* (Bodd.) in inland parts of Lower Bengal.

S. C. LAW, Calcutta.

Common occurrence of the bird in the Sunderbans and throughout the eastern coast of the Bay of Bengal. Discovery of its breeding area in inland parts, considerably away from the Sunderbans: nestlings obtained in *Churr* lands on the banks of the river Ichamati beyond Basirhat town. Juvenile characters described.

34. The status and distribution of the Indian Black-headed Shrike (*Lanius nigriceps* Frank.) in Lower Bengal.

S. C. LAW, Calcutta.

Erroneous observations of J. R. Cripps re: its status in Furreedpore district. Mr. Stuart Baker's record in F.B.I. (Birds) inadequate and somewhat misleading. Breeding area of the bird discovered in riverine tracts of Basirhat (24-Perganas), about 40 miles N.E. of Calcutta. Observations on the plumage of specimens, both adult and juvenile, obtained therefrom.

35. A comparative study of the lower limb muscles of *Loris lydekkerianus* and man.

A. ANANTHA NARAYANA IYER, Madras.

The Pectineus consists of two parts: one superficial and one deep corresponding to the double nerve supply from the femoral and obturator nerves for the Pectineus in man. There is a muscle 'Triceps Femoris' on the medial aspect of the thigh which is a fusion at insertion of Gracilis, Semitendinosis and a muscle for which there is no human equivalent taking origin from the Pecten Pubis superficial to the Pectineus. There is no tendinous insertion of Adductor Magnus to Adductor tubercle. The Biceps Femoris has no short head from Femur, the only origin being in common with the other Hamstrings from the Ischial tuberosity. There is no Peroneus tertius; no Plantaris. The Flexor Digitorum Longus and Flexor Hallucis Longus are so named in the paper only from corresponding origins and positions, for both the muscles supply all the toes. The interesting way in which these and Flexor Digitorum Brevis are inserted is described. The Popliteus develops a fairly well sized Sesamoid bone which articulates with the lateral condyle of the Tibia and takes part in the knee joint. The first toe and the little toe have opponens muscles like the upper extremity of man. Minor variations in other muscles are also described.

36. On the occurrence of *Sus namadicus* in Ariyalur.

C. R. NARAYAN RAO, Bangalore.

The paper deals with the occurrence of *Sus namadicus* and *Sus kurnooliensis* reported from the Kurnool caves and discusses the phylogenetic

relations of the South Indian Fossil Suinae with those discovered in the Siwalik Beds. An interesting point as regards the age of the Ariyalur rocks from which mammalian remains have been obtained and which present strong resemblance with the extinct Siwalik fauna is also touched upon.

37. On the evolution of the occipital condyle and the formation of 'Atlas' vertebra in the vertebrata.

H. K. MOOKERJEE, Calcutta.

The origin of the occipital condyles of the skulls and the formation of atlas of Vertebrata have not so far been elucidated. The condyles are separate elements from the occipital arch and are superimposed on the latter, except in fish. The occipital arch is the hinder limit of the skull; and the arch which is the beginning of the vertebral column may be termed the atlas, though it is not homologus in Anammia and Amniota. Between the occipital region and the atlas there is an intervertebral body which acts as a buffer. An intercalated arch is present on the dorsolateral sides of this intervertebral body, the existence of which was not previously known; this arch is not complete dorsally and does not enclose the spinal cord; the nerve, spinalis I, passes through or over this intercalated arch. In fish, the limbs of this intercalated arch lie on the sides, a little above the level of the intervertebral body, the division of which forms the heavy zygapophyses between the skull and the atlas. In fish the occipital condyle is formed only from the intervertebral body which acts as a buffer between the skull and the vertebral column and it is concave as the vertebrae of fish are amphicoelous. In Urodela, Anura and Mammalia the occipital condyles are formed only from this intercalated arch. In Reptiles and Aves they are formed not only from this intercalated arch but also from intervertebral body in addition. In Urodela and Anura the so-called atlas vertebrae have not only their own dorsal arcualia but also a part of the intercalated arch in question. In reptiles and birds, according to the generally accepted view the intercentrum represents the united basiventralia. Now, if the centrum of the atlas vertebra fuses with the axis centrum to form the odontoid process, we might naturally expect that the intercentrum belonging to the atlas vertebra should either remain with the dorsal (posterior) arch of the atlas ring or should fuse with the odontoid process of the axis; and in consequence the latter should have two intercentra instead of one as is actually found in the dried vertebra of the adult.

38. Certain vegetable juices and urine as histological fixatives.

A. NARAYANA RAO *and* S. RAMASWAMI, Bangalore.

Since publishing a short note on this subject in *Nature* (Vol. 127, No. 3312 datèd 23rd May 1931) the authors have extended the application of these new fixatives to every kind of animal tissue and in one case to the vegetable tissue as well. The paper deals with the relative values of these fluids as fixing agents for the study of the nerve endings in the muscles, the structural details of tissues and cytoplasmic inclusions, including nuclear changes in mitotic division. Practically in every case the results are quite constant and satisfactory as are those obtained by the older methods of employing pure chemicals recommended in Lee's *Vade Mecum*. We have tried with success some of these new fixatives in the study of placenta, the embryos of chick and frog, and several protozoa. Excellent results have been obtained on the smears of the testes and blood of frogs, crabs and *Loris*. We put forward the general theory that some, at any rate, of these juices, and urine especially, might replace the common fixatives now employed in micro-technique for all general purposes.

39. Spermatogenesis of *Schizodactylus monstruosus*, Don.

J. J. Asana, Ahmedabad.

Maxwell-Lefroy while assigning this insect to the sub-family Locustidae remarks in his book 'Indian Insect Life' that its systematic position is rather doubtful and that its habits are such that it may be a Gryllid. He also records that its distribution in India is a curious one including Tirhoot, parts of Assam, Bellary, parts of Sind and Multan. It is fairly common in Ahmedabad living in sandy soil near the river Sabarmati.

A detailed cytological study of its male gonads including the observations on the behaviour of the chromosomes, their shape, size and number has been made. Comparing these observations with the results of our study on the chromosomes of a number of Indian Locustidae previously recorded we find that the chromosomal complex, the sex chromosomes and the behaviour of the chromosomes at the stage of reduction division are entirely different from those of any locustid we have so far examined. Besides there is no similarity whatsoever in the structure and the general topography of the testis tubules in the contrasted forms.

In *S. monstruosus* the somatic number of chromosomes is 14 of which 12 are autosomes and the remaining two are a very large X—perhaps the largest chromosome in the whole complex—and extremely small dot-like y. This arrangement of x and y chromosomes, has not been so far seen in any Locustidae, though it has been recorded in one or two forms of Gryllidae.

40. Yolk nucleus in the spider *Plexippus paykulli.*

Sukh Dyal.

Fresh eggs measuring 0·1 mm. show a circular structure with a peripheral fibrous shell enclosing fine vesicles. The rim of each vesicle goes black in 2 per cent. osmic acid slightly. Younger oocytes do not show this structure. When the albuminous yolk puts in its appearance this structure disappears.

Work on the nature of this structure is in progress. It will be interesting to ascertain if it represents any one of the well known cytoplasmic inclusions or whether it is altogether an independent structure.

41. Oogenesis of rabbit.

Sukh Dyal.

In the outer germinal epithelial lining of the ovary and the interstitial cells, both of which give rise to oogonia, the mitochondria and the golgi elements are in a juxtanuclear position. In later stages these elements arrange themselves in the form of a circumnuclear ring. This expands peripherally till the whole of cytoplasm is invaded by its contents. Whereas the mitochondria are granular, the golgi elements are in the form of vesicles, each vesicle showing an osmiophilic or argentophilic rim and an osmiophobic or argentophobic centre. There is neither fat nor albuminous yolk. In fixed preparations the older oocytes show clear vacuoles, but as vital study is precluded by the enclosing secondary cells of the ovary, it is impossible to say whether they correspond to the vacuome.

Section of Botany.

President:—HARAPRASAD CHAUDHURI, M.Sc., Ph.D., D.I.C.

Presidential Address.

THE SCIENCE OF PLANT LIFE IN INDIA—PAST AND PRESENT.

More than 2,500 years ago JIVAKA, when he finished his study of natural history in the famous University of Taksasila (Taxilla), was asked by his teacher BHIKSHU ATREYA to collect, identify, and describe the properties of all plants to be found within a radius of four jojanas (eight miles) around Taxilla.[1] Bhikshu Atreya was himself the author of several scientific treatises, but long before his time, the science of plant life had developed along the two natural channels of practical utility, viz. botany of the medicinal plants and botany of the agricultural plants. AGNIVESA, JATUKARNA, BHELA and HARITA, all disciples of Atreya (son of Atri, not Bhikshu Atreya), CHARAKA (redactor of Agnivesa), DHWANNANTARI, his disciple SUSRUTA and NAGARJUNA (redactor of Susruta) are all great names in ancient India famous for their knowledge of medicinal plants and of their uses in alleviating the sufferings of humanity. The two great names of this Aurvedic period, as RAY[2] calls it, are Charaka and Susruta; but though not methodised and arranged on a rational basis with a scientific terminology, the study of the medicinal plants had begun more than a thousand years before this time. We have the foundation in the Vedic period specially in the Atharvan and Rig. Regarding agricultural botany it is clear from the recorded evidence that the earliest mention of agriculture occurs in a hymn of the Rig Veda[3] which shows us 'that India was peculiarly fit for agriculture which was the then staple industry of the country, the source of the supply of food and the universal occupation of the people'. The early records of plants and scientific agricultural practices, we find in the VRIKSHAYURVEDA (science of plant life) chapter of Agnipurana—an ancient popular cyclopædia of all kinds of knowledge. Both in KAUTILYA's Arthashastra and in VARAHAMIHIRA's Brihatsamhita, we come across chapters on Vrikshayurveda. From these we find that the ancient

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[1] V. Sen—in Vanaushadhi Darpana.
[2] Ray—History of Hindu Chemistry.
[3] Quoted in Vanaspati (G. P. Mazumdar).

science of plant life in reference to agriculture consisted in collection and selection of seeds, germination, grafting, cutting, sowing, planting, and nursing, selection of soil, measuring and cultivation of soil under favourable meteorological conditions and the location of plants for improving the æsthetic and hygienic surroundings of the homestead. Even the requisite qualifications of agricultural officers and their assistants have been noted in detail. From the study of the sections on Vrikshayurveda in the works noted above as also the independent treatises on agriculture (Krishitantra) by KASYAPA, PARASARA and SARASWATA, fragments of whose works only have reached us, there can be no doubt that in ancient India not only the study of the medicinal plants but also that of the agricultural plants, including horticulture and plant-breeding, reached a very high standard of development. Bheshaja Vidya, a distinct study of plants and plant life with special reference to medicinal properties and use (Dhwannantari Nighantu) was coming into its own. The advance India made more than two thousand years back in agriculture, horticulture and other branches of applied botany is simply astounding. HOWARD[1] mentions how with great care and skill the Indian cultivator grew a semi-aquatic crop like rice on the steep hill sides of India and Ceylon and how he developed different agricultural methods and varieties of crops to suit the conditions of the soil and climate in the different provinces. All these, he says, cannot fail to command our attention and respect.

According to ROXBURGH, the western world is indebted to India for teaching her rotation of crops. The effect of climatological and meteorological factors on agriculture was well known to them and they regulated the cultivation of crops accordingly. In meteorology, the Hindus used the rain-gauge in the weather forecasts of the year[2]. Thus we find that in ages long past and forgotten, the importance of meteorological studies in reference to agriculture was realised.

The ancients did not ignore the study of plant physiology. Their statements regarding germination, nourishment, transport, transpiration, assimilation, respiration, growth, movement, age, death, consciousness, sexuality and reproduction were sometimes astoundingly correct and the result of critical observation; but in many places these were mixed up with philosophic speculations. Their great handicap was no doubt the absence of microscopes, and hence the detailed anatomy of the higher plants was unknown to them as also the structure of the minute organisms. UDAYANA (Kiranavali

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[1] Howard, A.—Presidential Address, Ind. Sci. Congress, Bom., 1926.
[2] Seal, B. N.—Positive Sciences of the Ancient Hindus.

—chapter on Prithivipuranam) notices in plants 'the phenomena of life, death, sleep, waking, disease, drugging, transmission of specific characters by means of ova, movement towards what is favourable and avoiding what is unfavourable'. GUNARATNA enumerates various kinds of movements and actions connected with sleep and waking. In Sankara Misra's Upaskara and in Gunaratna's commentary on Saddarshana Samuchaya we find references to natural healing of wounds in plant organs.

The science of horticulture attained a tremendously high degree of development. Practically all modern methods of plant propagation were known. Beside propagation by fruits and seeds (bijaruha) we find mention of propagations by roots (mulaja), by cutting (skandaja), by grafting (skandhe ropaniya), by apical portions, by budding (agrabija), by leaves (parnayoni), by joints as in reeds and sugarcane (*pholu-bijam*), and also by layering. The last method is described in detail in Onesikritos and the others in various places in Rig, Atharvan, Manu, Arthashastra, Brihatsamhita, Maskarin Gosala and Buddha Ghosha.

The study of plant ecology was not neglected by the ancients. Charaka (B.C. 800) divides land into different regions according to the nature of the soil (edaphic conditions) and climate (climatic conditions) that determines the characteristic vegetation and also mentions the plants characteristic of each region. Charaka did not fail to notice that in some places a particular species predominated over others. These places have been given the name of the species dominating to the exclusion of others, e.g. where reeds abound, Nadvala; those abounding in vetra (ratans), Vetraswan; and so on.

Now regarding nomenclature and classification obtaining in ancient India, it is interesting to recall the remarks of SIR WILLIAM JONES, the Founder-President of the Asiatic Society of Bengal, in which he says, 'that Linnæus himself would have adopted them had he known the learned and ancient language of this country'.

The Hindu classification of plants was based upon three distinct principles, viz., (*a*) botanical (Udhvida); (*b*) medicinal (Virechanadi) and (*c*) dietic (Annapanadi). 'The observations were no doubt mainly in the interests of Materia Medica and the classification was as superficial as possible (Seal)'.

Very few of the lower plants were noticed; but they did not fail to study the mushrooms. These were no doubt studied for their gastronomic interest. No mention of the use of fungi is found in the elaborate medicinal treatises. In Susruta's classification the mushrooms are put in the 12th group (Udhvida group) as sprouting up from beneath the surface of the ground. Its properties according to place

of origin have been given. For example, *palalam*, i.e. those growing in straw 'are sweet in taste and digestion and tend to produce a state of dryness in the organism. They subdue the three deranged humours of the body', and *karisham*, i.e. those growing in cow-dung 'leave an astringent after-taste in the mouth. They aggravate the Vayu, and are heat-making in their potency'. The palalam no doubt is an agaric and the karisham a Coprinus sp., but only a few species were studied by them. In Bhavaprakasha, the mushrooms are described as Samsvedaja (moisture-born) and only the white variety has been recommended as vegetable, the rest being left out as poisonous. It may be noted here that the Mahomedans, who were great epicures, when they came to this country, had not only the mushrooms of the Udhvida group on their table but also those that remain buried. And just as hounds are employed in Europe in truffle-hunting, the Mahomedans employed cheetahs (leopards) for the same purpose. Even to-day, in one of the Mahomedan States in India, the practice is still continued.

Mycologists and plant pathologists will no doubt be interested to learn that our ancient botanists and agriculturists not only recognised diseases in plants but also carried on treatment of those diseases. As they had no microscopes, it was not possible for them to recognise the disease-causing organisms which were then ascribed to environmental factors and they had to go by symptoms. We all know that the symptoms in plant diseases are very much generalised and the same symptom may be shown by different diseases. They conducted a sort of general treatment for preventing as well as curing those maladies. Says GUNARATNA in his commentary on Saddarshana Samuchhaya, 'Just as the human body is subject to jaundice, dropsy, emaciation and defects of finger, nose, etc., so also plants suffer from various similar diseases. And just as by the application of the appropiate remedies, unnatural growth, deterioration, wounds, fractures, etc., can be cured, so also in plants by application of proper drugs as prescribed in Vrikshayurveda'. SANKARA MISRA also in Upaskara notices application of drugs in plants. VARAHAMIHIRA gives the following signs of the diseased condition in plants:—'When a plant is diseased leaves become yellow, buds do not develop or their growth becomes arrested, branches become dry and the sap exudes.' KASYAP says, 'those plants that have yellow leaves, that are fruitless and denuded of leaves, and those caused by coldness, excess of heat, too much of rain and by the intermingling of roots of different plants (root parasitism?) are to be known as diseased and are to be treated accordingly.'

'For treatment of those diseases remedies have been prescribed, both preventive and curative. Even in Agni-

purana we find recipe for treating the barrenness of fruit trees, as also for promoting inflorescence, for ensuring the formation of vallaris, i.e. sprouting and growth of luxuriant stems and foliage. From the elaborate recipes given it will be seen that they were contrivances for supplying the requisite nitrogen compounds, phosphates and 'bacteria', these being potentially contained in the mixtures and infusions prescribed' (Ray[1]).

The ancients believed that the plants had preceded animals and men. This we find in the writings of UDDALAKA, YAJNYAVALKYA and others. Buddha's idea of evolution is not very far from the truth. After describing the formation of the sun, the moon and the stars and the planets from one hot mass, he continues, 'Meanwhile the cooling process goes on. As the juicy earth gradually becomes hardened, it loses its flavour and sweet taste but vegetation first of lower, then of higher grade evolves. Man descends at length from the heavenly ancestors—from the vital sun or the reflective moon'.[2]

It is interesting to note that Indian biologists more than 2,000 years before Darwin and Weismann thought about the problems of heredity. In Charaka and earlier still in the Brahmanas, we find described what parental characters are transmitted to the offspring and how (Seal[3]).

In these pages I have tried to put before you what India contributed towards world-knowledge regarding everything concerning plant and plant life during 2,000 years, beginning from about a thousand years before the birth of Christ to CIRCA 1200 A.D. During that period India reached the height of her glory. Agriculture in the 4th century B.C., became a department of the government. Megasthanes, the Greek ambassador at the court of Chandra Gupta, pays an eloquent tribute to the standard of agriculture at that time and also the respect in which agriculture and the agriculturists were held. Even at the time of war, the combatants used to leave the agriculturists undisturbed as a matter of duty. Thus, 'whereas among other nations in the contests of war to ravage the soil and thus to reduce it to an uncultivated waste is the practice, among the Indians, on the contrary, that is sacred and inviolable ; the tillers of the soil, even when battle is raging in the neighbourhood, are undisturbed by any sense of danger, for the combatants on either side in waging the conflict make carnage of each other but allow those engaged in husbandry to remain quite unmolested. Besides they neither

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[1] Ray—*Ibid.*

[2] Vanaspati. The writer is indebted to Mr. Mazumdar, the author, for much of the above information.

[3] Seal—*Ibid.*

ravage an enemy's land with fire nor cut down its trees'—a thing which the modern civilised nations may very well emulate. ASOKA too, as is clear from his edicts, looked upon the encouragement of agriculture not only as a political duty but also as a moral duty. But soon after the Buddhistic period, began the dark days of foreign domination and the consequent decline in her arts, science, and industries. The scientific principles underlying the art of agriculture came to be forgotten, and agriculture instead of being a concern of the State, a matter of expert knowledge, came to be the occupation of the lowest stratum of the population with consequent stagnation and degeneration. 'From the time which marked the decline of Buddhism commenced the dark ages of India and for at least 1,000 years or more, India has been a *tabula rasa* so far as the cultivation of physical sciences is concerned' (Ray[1]). In that period we find no cultivation of botany or any of its applied sides and no botanical literature of that period exists. Ray says, 'With the decay of the Hindu and Buddhistic culture, an intellectual torpor took possession of the Indian mind and the spirit of enquiry after truth rapidly declined. Authority of the Shastras took the place of reason and clouded human intellect. A state of mind was thus fostered which was inimical to the study of science, which accepts things not on trust but on verification.

'The Indian mind lay in this condition till the beginning of the 19th century when new conditions of things arose out of the establishment of British rule. This contact with the west brought in new ideas and new modes of thought in Indian life.'

I hope to be excused for dealing with past botany a little too elaborately, for I could not, like Sir George King, dismiss the whole as vague, obscure and unscientific.[2]

Indian botany was reborn as a result of contact with the west in the 18th and 19th centuries. The Portuguese who were the first Europeans to come to India did very little for botany. The reference to the earliest paper in Blatter's bibliography[3] is to ACOSTA's paper on medicinal plants published in 1578. The earliest reference to Indian botanical literature proper is perhaps that of Henry Van Rheede, the Dutch governor of Malabar who in 1676, made a large collection of plants through the agency of a brahmin. These were sent to Cochin where they were figured and described in Latin and published as *Hortus Malabaricus* from Amsterdam in 12 volumes with 794 plates during 1686–1703. The

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[1] Ray—Presidential Address, Indian Sci. Congress, Nagpore, 1920.
[2] Sir G. King—Pres. Address, K. Sec., British Assoc., Dover, 1899.
[3] Blatter—Journ. Bom. Nat. Hist. Soc., Vol. XX, No. 5.

descriptions were later pronounced to be correct by Linnæus (Bose[1]).

Before the middle of the 18th century, the published works which were mainly descriptions of flowering plants, were on uni-nomial system. Here we find the names of RUMPH, PLUNKETT and JOHN BURMAN among others in the list of contributors. HERMAN'S Cingalese collection was described by Linnæus himself (Flora Zeylanica, 1747), and the bi-nomial system was introduced to India by KOENIG, a pupil of Linnæus. The arrival of Koenig in India in 1768 has been called the beginning of a new chapter by King, which continued till the arrival of SIR JOSEPH HOOKER in 1848 when fresh impetus was given to botanical studies and a new chapter begun.

John Gerard Koenig went out to the Danish settlement at Tranquebar (150 miles south of Madras) and he formed a society there called 'The United Brothers' chiefly for the promotion of botanical study. HEYNE, KLEIN, ROTTLER and later FLEMING, ANDERSON, BERRY, JOHN, ROXBURGH, BUCHANAN (afterwards Buchanan-Hamilton) and SIR WILLIAM JONES were members of this 'brotherhood'. They exchanged specimens for study and also sent out specimens to Europe. These have been described by RETZ, ROTH, SCHRADER, WILLDENOW, VAHL and SMITH. The French botanist SONNERAT and others sent out specimens from the French settlement at Pondicherry and these have been described by LAMARCK and POIRET.

The greatest event of this period in the history of botanical research in India was no doubt the foundation of the Royal Botanic Garden in Calcutta (1787). This was made possible through the exertion of Lieut.-Colonel ROBERT KYD, who was Military Secretary to the Governor of Bengal and a keen botanist. With the establishment of the Botanic Garden in Calcutta, a recognised centre of botanical activity in India was formed, and with it began an association of a series of very brilliant botanists to whom we cannot but look up with gratitude and respect. The scientists in India will be failing in their duty if they forget how much they owe to the Asiatic Society of Bengal which was established in 1784 by Sir William Jones—a great orientalist and botanist who called 'botany the loveliest and most copious division in the science of nature'. For more than 100 years the Journal of the A.S.B. published most of the papers on natural history contributed by the Indian scientists at that time in a separate natural history volume.

In 1793, after Kyd's death, WILLIAM ROXBURGH of Koenig's United Brotherhood was appointed superintendent of the Calcutta Garden. He was the first to reduce the

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[1] Bose, P. N.—Centenary Review, Asiatic Soc. Bengal, 1885.

plants of the east to the form of a flora. After him, NATHANIEL WALLICH of Copenhagen became superintendent (1815) and worked for 30 years. Dr. Wallich first came as a Surgeon to the Danish settlement at Serampore and was taken prisoner when that place was captured by the English. His reputation as a botanist however induced the Government not only to liberate him but place him in charge of the Calcutta Botanic Gardens (Bose[1]). Wallich made vast collections which he took away to London. These along with the collections of Heyne, Rottler, Buchanan-Hamilton and Roxburgh were classified and named specifically by DE CANDOLLE, KUNTH, LINDLEY, MEISSNER, NEES VON ESENBECK, VAN MARIUS and BENTHAM. During Wallich's time, ROBERT WIGHT was labouring in south India, and a French Botanist VICTOR JACQUEMONT, at the instance of the Paris Nat. Hist. Museum, travelled extensively in India, making large collections of plants (1829–32). Jacquemont died in Bombay, and his collections were worked out by Cambessedes and Decaisne.

The roll of eminent botanists, who worked in India during the first half of the 19th century, closes with THOMPSON. He made vast collections in the U.P., and the Punjab, and his work was incorporated both in 'Flora Indica' and 'Flora of British India'.

A second centre of botanical research was started in India in 1820 at Saharanpore when a large garden of a Mahomedan noble was taken over by the East India Company. With it are associated the names of GOVAN, ROYLE, FALCONER and JAMESON before the middle of the 19th century. Considerable work was done in the first half of the last century by GRAHAM, LAW, NIMMO, GIBSON, STOCKS, and DALZELL in Western India; by HARDWICKE, MADDEN, EDGEWORTH, LANCE and VICKAY in Northern India; by JENKINS, MASTERS, MACK, SIMONS and OLDHAM in Assam; and by STRACHEY and WINTERBOTTOM in Kumaun, Garhwal and adjacent Tibet.

The next period of advance in botanical research began with the visit of Sir Joseph Hooker to India in 1848. He spent most of his time in India in exploring the flora of Sikkim along with Dr. THOMAS. His Flora of British India was published between 1872 and 1897 with the assistance of Baker, Sir W. Thiselton-Dyer, Bennet, Anderson, Edgeworth, Hiern, Lawson, Masters, Stapf and Gamble. Since Sir Joseph Hooker's visit to India, very important work has been done by CLARKE and ANDERSON. SULPIZ KURZ has also contributed to the forest flora of Burma along with Burness, Mason and General Sir Henry Collet. Aitchieson in 1867 published the list of the Punjab plants. Stewart, Beddome,

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[1] Bose, P. N.—*Ibid.*

Sir D. Brandis, Talbot and Gamble, all of the Indian Forest Department, were making important contributions to Indian botany. Other forest officers of note before the close of the 19th century are LACE, HEINIG, HAINES, McDONELL, ELLIS, OLIVER, UPENDRA NATH KANJILAL and BOURDILLON (of Travancore). During this period, Noton, Perrotet, Metz, Hohenacher, Schmidt, Bidie and Lawson worked in Madras. The Poona herbarium in Bombay Presidency was now started through the exertions of COOKE, WOODROW, RANADE and LISBOA—all enthusiastic botanists. J. F. DUTHIE at Saharanpore (after Jameson in 1872) and McCLELLAND (1848), FALCONER (1848), JAMESON (1855), ANDERSON (1861), CLARKE (1870), KING (1871), and PRAIN (1897) at Calcutta were contributing to botanical literature during the latter part and close of the 19th century. Fossil flora was first systematically surveyed by DR. O. FEISTMANTEL at this time. The Botanical Survey was formed about 1890 in which the four establishments of botanical research at Calcutta, Saharanpore, Madras and Poona were incorporated without taking away their individual control. The Records of the Botanical Survey began to be published, as also the Annals of the Royal Botanic Gardens, Calcutta.

Next to taxonomic work, in this period, we find that good work on economic botany has been done. In 1883, Government created the post of 'Reporter of Economic Products of Government of India'. DR. GEORGE WATT of the Bengal Educational Service was appointed to that post, and he compiled the 'Dictionary of Economic Products' in which not only vegetable but also animal and mineral products were included.

The tea industry in India was established through the efforts of the botanists. In 1826, DAVID SCOTT showed that tea grew wild in the forests of Assam, and in 1835, WALLICH, GRIFFITH and McCLELLAND were deputed by the Government to visit Assam and report on the indigenous tea; and as a result of their efforts, the tea industry was established in India. In the introduction of cinchona also, the botanists played their part. On being pressed by ROYLE, FALCONER, THOMPSON and ANDERSON, the Government took action, and through the labours of Sir Clement Markham and Hooker, the medicinal cinchonas were introduced into India between 1861 and 1868.

The history of the introduction of rubber into India is quite interesting. In 1876, H. A. Wickham, without any authority, pledged the credit of the Government of India to charter a new ship, and before the Brazilian government could know of anything smuggled out from the mouths of the Amazon a good quantity of the seeds of *Hevea*. He brought these to Sir Joseph Hooker at Kew. These were

grown in the Orchid houses at Kew and then shipped to India, Ceylon and Singapore. The Botanists have also taken a leading part in another economic enterprise of the Government, viz. the Forest Department. In its earlier years, botanists like GIBSON, DALZELL, CLEGHORN, ANDERSON, STEWART and BRANDIS moulded its character.

In the botanical researches of the 19th century and earlier, we find very little work done in cryptogamic botany. Besides Griffith, Clarke and Hope, Beddome contributed to our knowledge of Indian ferns. In concluding his address, Sir George King said, 'As regards cryptogamic botany, there is little to relate. Except Griffith, no Indian botanist before 1850, did any serious work amongst non-vascular cryptogams. After that period, two have done excellent work, viz. Dr. ARTHUR BARCLAY and Dr. D. CUNNINGHAM'. Barclay worked mostly on uredinous fungi, and Cunningham described several diseases of plants caused by fungi as well as by an alga. MITTEN's work on Indian mosses (1859) is also notable. KING[1] regretted that in the past cryptogamic botany had not been studied in India as it ought to have been or might have been.

The 19th century is now past; let us see what we have been doing since the beginning of the 20th century.

For the first ten or fifteen years of the present century we find that the original papers contributed are almost all confined to the European members of the higher services. That is nearly fifty years after the establishment of the bigger universities in India, Indians were not contributing anything materially in the field of botany or any other science. Ajrekar[2] rightly pointed out that 'this state of things is the heritage left to us by the early British administrators, who in organising the educational institutions in India aimed at nothing higher than producing candidates for services in the subordinate ranks and persons who would be just good enough to act as interpreters between the rulers and the ruled'. Even when research institutions were established, Indians did not get opportunities for research; they were thought to be lacking in capacity for original work. Ajrekar mentions the slogan 'that Indians are inherently incapable of independent research work and they can at best be fitted to work as assistants in research'. Sir J. C. Bose's life is a noble and inspiring example before us of how it is possible to produce original work against great odds, and his first paper read before the A.S.B., in 1895, really marks the beginning of the 'reproductive period' (Ray[3]). Indians are again

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[1] Sir George King—*Ibid.*
[2] Ajrekar, S. L.—Pres. Address, Ind. Bot. Society, 1927.
[3] Ray—Nagpur Sci. Congress, 1920.

contributing towards world knowledge in all branches of science, and nobody dares to question to-day the Indian's capacity for original work in the scientific field.

The growth of national consciousness amongst Indians contributed materially in bringing about this change. Indians went abroad in large numbers for studying science and specialised in different branches. Conditions in the government research departments for the pioneers were no doubt very discouraging. They were being relegated to subordinate positions and did not get proper facilities for research, Indians looked forward to the universities, and with the establishment of newer universities and encouragement of research in the older ones, they found their footing. To-day there are 18 universities and a large number of constituent colleges, and in many of these institutions research work is being conducted by Indians. Though research in botany has not found so many votaries as in chemistry for various reasons, it is nevertheless thriving healthily. Practically in all branches of botany, research is being carried on to-day. I come from the Punjab, and it is but natural that in reviewing the botanical work in the different Indian universities I should start with the Panjab University. It is a privilege to me to welcome our general president, Professor S. R. Kashyap, a botanist from the Punjab. I need not tell you about his life-long services for the promotion of botanical research. To-day his pupils are occupying important teaching and research posts throughout the length and breadth of the country. Besides Prof. Kashyap, Ghosh and Chaudhuri have been carrying on research and guiding research students in algology and plant pathology. Research work has got a special impetus in the Panjab University in that in those subjects in which three years' honours schools have been established, the Master's degree is awarded only on the merits of research work done. In spite of difficulties in many of the affiliated institutions, research is being done by the teachers, e.g. Stewart in Gordon College, Pindi; Sethi in Multan College; Anand in S. D. College, Lahore. In Lyallpur where M.Sc. in Agriculture is given only on the result of research done, Luthra has been working on physiology and plant breeding. A brilliant life was cut short by the death of Kirpa Ram Mohindra of the same college who started contributing and guiding research in mycology after his return from Europe recently.

In Agra University, Mehta has been doing interesting and important work on wheat rusts and Maheswari in Plant anatomy.

In Lucknow University, Sahni has the distinction of being the only botanist doing important work in palæobotany and had the privilege of presiding over the deliberations

of both the botany and geology sections of the Indian Science Congress. Mukerji has been busy utilising his expert knowledge in dealing with ecological problems, and Chowdhury, Pande, Singh and others are dealing with various aspects of the subject.

In Allahabad University, we have Mitter in mycology, Shri Ranjan in physiology, and Dudgeon in ecology, morphology and cytology conducting and guiding research work.

In Benares Hindu University, Inamdar and his disciple B. N. Singh have been contributing in physiology, Tewari in morphology and Bharadwaja in algology.

Of the five university centres in the U.P., viz. Allahabad, Lucknow, Benares, Agra and Aligarh, we find research schools in botany firmly established in the first four. It is a pity botany has not flourished so well in the last named university centre. Very recently, however, Rafique, on his return from Europe, has started research in physiology and we hope Aligarh will soon become a centre of research work. Outside the university, we have Allen's work on characeæ and Kenoyer's on ecology to mention.

The only place for botanical research in Behar and Orissa under the Patna University is Cuttuck where Parija is working in physiology.

Of the two universities of Bengal, viz. Calcutta and Dacca, no higher teaching in botany is done in the latter. In the former the first university chair in botany was occupied by Brühl, who began his botanical contributions in the early seventies. His disciple and collaborator Biswas, now Curator of the Herbarium, Royal Botanic Gardens, is making notable contributions on algology. In the university laboratory, Agharkar in ecology and morphology, and I. Banerjee in cytology, and in the Presidency College, S. C. Banerjee, Mazumdar, Sen and K. Banerjee have been contributing original papers. In the Bose Institute, Sir J. C. Bose and his assistants have been busy probing the mysteries of plant life, and in the Carmichael Medical College, S. R. Bose has been silently engaged in increasing our knowledge of the Bengal polyporaceæ.

In Rangoon University where higher botanical studies were inaugurated by Ghosh, original papers are being contributed by Handa and Prasad after Ghosh's return.

In Nagpur University where higher studies in botany began only recently, Nirula has been doing good work in algology. In the Agricultural College, Dastur (J. F.) has been making valuable contributions in mycology, and Mahata has interested himself in economic botany.

From Madras University, Fyson in angiosperms, Iyengar in algology, and Ekambaram in physiology have been making valuable contributions.

In Mysore University, Sampatkumaran and his pupils are working mainly on cytology, and certain aspects of the spike disease are being investigated in the Indian Institute of Science at Bangalore.

In Bombay University, Blatter in taxonomy, Ajrekar in mycology, Dastur (R. H.) in physiology have been busy contributing and guiding research work. Saxton and Sedgwick were till recently contributing from Bombay. In the agricultural and horticultural departments of the states and the government, we have Uppal, G. S. Kulkarni, Likhite, Cheema, Patel, Prayag, Kottur, Thadani, Bhide and others.

In the newer universities of Andhra and Annamalai as well as in the Osmania University and in the Imperial University of Delhi, no higher teaching or research in botany is done. These universities, let us hope, will not be late in realising the importance of botanical studies and soon arrange for it. Our neighbours in Ceylon have not neglected botany; from Colombo, Ball, Sarbadhikari and Petch among others have been making valuable contributions.

The above is only a brief list of the botanical workers in the different universities. Though many names have been missed, I have tried to show that botanical researches in their various aspects are no longer neglected and that the opportunities of botanical research in India pointed out by Dudgeon are no doubt being increasingly seized. At present, besides the universities which have greatly helped to stimulate research amongst Indians, valuable work is being done in the Agricultural and Forest departments as well as in the Botanical Survey. Gage, Calder, Deb-Barman, Ramaswami, Biswas, Hooper, Carter of the Botanical Survey; Stebbing, Troup, Hole, Gamble, Bamber, Parker, Bagchee of the Forest department; Butler, Howard, Mrs. Howard, McRae, Shaw, Dastur, Mitra, Burns, Hector, Sabnis, Sundararaman, Ranga Achari, Pillay, Joshi, Narasimham, and Rao of the Agricultural department among others have made valuable contributions in different branches of botany. Kirtikar and Basu's 'Indian Medicinal Plants' is a great contribution.

The Indian Botanical Society, founded in 1920, and the Journal of the Society, as also the Indian Science Congress under whose auspices we meet to-day, have given great impetus to young botanists for research, and we are thankful to them.

The establishment of the Imperial Agricultural Research Institute at Pusa and the Forest Research Institute and College at Dehra Dun are important events of the present era, for at the beginning, research was almost exclusively done by the members of the Imperial Services.

No longer are the lower plants neglected. They are receiving more and more attention every day. Dudgeon among other things mentioned about the work done in various groups of the lower plants (1922) and Iyengar dealt exhaustively with work on algology (1928). Mehta discussed the incidence of rust in the U.P. (1929). Kashyap's Liverworts (1929) and Brühl's Census of Indian Mosses (1931) are valuable contributions.

In the addresses delivered before the Indian Science Congress. Hole (1918, Botany), Finlow (1925, Agriculture), and Howard (1926, General President) made references to plant diseases. Both Hole and Howard advocate the study of the ecological factors more fully in connection with the control of diseases since, as Hole pointed out, factors like water deficiency and aeration not only can kill plants but making them sickly render them liable to attack of one or more organisms. Finlow suggested research with a view to find out the effects of certain salts on plant diseases. We know the three factors—host, parasite and the environmental conditions all play a part in the production of disease and 'the physical factors of environment are often of considerable and in some cases of paramount importance in the inception and spread of disease in plants' (Pethybridge[1]). As I am more interested in the study of plant disease, a subject in which not only the botanists but also the agriculturists are interested, I claim your indulgence to speak a little more about mycological work in India.

In recent years considerable work has been done in India on plant diseases mainly in the agricultural research institutes and colleges. But it is no longer confined to those departments. The universities and colleges are taking their proper share of work in this branch also. Fungi and diseases of plants form part of the curriculum of higher courses of botany in many of the universities to-day, and contributions in mycology are being made regularly from the Panjab, Agra, Allahabad, Bombay and Calcutta universities. In the Panjab University, the honours school students have to undergo a compulsory course in plant pathology, and many students take up research work in that branch for their M.Sc. degree. But more work on plant diseases should be associated with the various universities, and in co-operation with the agricultural and forest departments much more useful work could be done. With the increase in mycological work, the establishment of an Indian Bureau of Mycology has become an imperative necessity. The Bureau should not only supply information, and literature but also maintain a culture station of tropical fungi on the lines of the Culture Bureau

[1] Pethybridge—Presidential Address, British Myco. Soc., 1927.

in Holland. This, if properly done, will go a long way in helping higher work in mycology in India. The cryptogamic departments of the British Museum at South Kensington and the Kew Gardens, though mainly doing taxonomic work, are a great help to workers abroad, and one can always look forward to Mr. Ramsbottom or Miss Wakefield for ungrudging help. But conditions in India are very different in the corresponding departments. Hence the urgent necessity for an Indian Bureau of Mycology. The newly constituted Imperial Research Council has given a great impetus to the study of applied botany. Among others, the Agra and the Panjab Universities have been fortunate enough to secure grants for investigation of certain problems on plant diseases. It has also sanctioned a scheme for the investigation of the mosaic disease of sugar-cane. Very little work on the virus diseases of plants has been done in India, though they are by no means of rare occurrence. The problems are numerous and difficult to solve in the tropics, since experience of the west cannot always be applied here and 'few tropical countries have as yet progressed far in the study of plant disease' (Butler[1]).

To the Indian mycologists the work of Butler will always stand as an inspiration. He first came to this country as a cryptogamic botanist to the Survey in 1901 and was posted in the Calcutta Garden. Soon after, he was transferred to Dehra Dun to the newly-formed Imperial Department of Agriculture, and when the Institute at Pusa was built (1905) he was appointed the first Imperial Mycologist. There has been no mycological work in pre-Butler days except descriptions of fungi, causing diseases of plants by Barclay and Cunningham to which reference has already been made. Random descriptions of fungi published during the latter half of the 19th century are those of Currey, Cooke, Berkley, and Kirtikar among others. The Indian Tea Association founded a scientific department in 1900, and many diseases of tea have been worked out by Watt and Mann; and now they have a mycologist in Tunstall. The South Indian planters have also a mycologist and some of the Indian States too. Coleman, the Director of Agriculture, Mysore, first came as a mycologist there. Soon after Butler joined Pusa, other posts of mycologists were created there. Many parasitic diseases of cereals, pulses, root crops, oil seeds, drug and spice crops, fibres, palms, sugar-cane as also the chief plantation crops of tea, rubber and coffee have been studied; but the diseases of tropical fruits and forest trees have not been intensively studied. A forest mycologist has been appointed, and Bagchee has already done good work regarding pine-rust.

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[1] Butler—Presidential Address, Brit. Myc. Society, 1929.

The importance of economic mycology in an agricultural country like India cannot be over-estimated. There are over 80,000,000 acres under rice and over 30,000,000 acres under wheat in India; and in a normal year India exports nearly £150,000,000 worth of tea, jute and cotton. The losses due to diseases are simply enormous. The smut of jowar alone causes a loss of over a million pound sterling in the Bombay Presidency and 'practically the whole of this is preventible' (Butler[1]). This is mentioned simply to show what enormous losses even due to a preventible disease are suffered by the country. The number of mycologists in this country is too small and quite inadequate for the requirements of the country. There are only about a dozen mycologists in Government employment, but instead of appointing more, vacancies in a number of posts for mycologists have not been filled up and not all the provinces of India have their own mycologists. It seems those in authority do not realise the importance of plant protection: to what else could this indifference be due? Schemes sanctioned by the Imperial Agricultural Research Council after much deliberation for various agricultural developments have been held up.

To-day the brunt of the research work in India in all branches of science is being rightly borne by Indians. 'The work they have done has not only brought credit to India, but promises to be of real national importance . . . . India to-day needs the services of these young men and India to-morrow will regard the training and experience they are acquiring as priceless national assets . . . It is a great misfortune for India to-day that in her higher administrative circles there seems to exist an insufficient appreciation of the close relation between scientific research and national welfare . . . . It is an easy thing, a fatally easy thing to do, to destroy the career of a young man of science by administrative action. But to create a man of science, possessing sufficient knowledge and experience to be useful to his country, needs long years of preparation and cannot be done at short notice by a stroke of the administrative pen . . . Curtailment of scientific research activities because of insufficient appreciation of their importance will prejudice the future of science in India and be disastrous to the best interests of the country.'

The above warning was uttered by one of the greatest Indian scientists of the day, Sir C. V. Raman, in a meeting last August in Bombay over which His Excellency the Governor of Bombay presided. But this apathy towards science is not peculiar to this country. Pethybridge in his presidential address to the British Mycological Society (1927) said, 'A general apathy towards science, a positive dislike to it in

[1] Butler—Fungi and diseases in plants.

some quarters, our habit of "muddling through" our difficulties somehow and of stupidly being proud of doing so, have been characteristic of this country in the past; and much has yet to be done to enlighten not only the man in street, but also some of those in high authority, of the rightful place of Science in our national life.' If that is true of Britain, it is much more true of our country. The scientists in this country, however they may dislike it, will also have to enlighten not only the man in the street but some of those in high authority of the rightful place of science in our national life.

The development of Indian botany is in the hands of the Indians once again to-day. Whatever may happen, let us hope that the hands of the clock in the progress of botanical research in India will never be put back. We, the seekers after truth of plant life in India to-day, will not lag behind the rest of the world in the forward march of science.

I thank you all for a patient hearing.

Section of Botany.

Abstracts.

ALGAE.

1. A contribution to our knowledge of the Diatomaceae of the Punjab.

S. L. GHOSE *and* ABDUL MAJEED, Lahore.

The systematic study of the Diatoms inhabiting the soil and fresh water has not so far been attempted in India. A fairly large number of samples were collected from diverse parts of the Punjab from October 1930 to April 1931. In this paper nearly 60 species, representing 16 genera, with details of specific characters are recorded and their figures given. A map showing the principal localities of the collection is also appended. A short sketch of distribution and occurrence of these species is also given. Bare wet garden lawns harbour a few species of *Nitzschia* and *Navicula*. Ponds, pools and tanks are the most productive places and epiphytic diatoms also form an interesting part of the study of the Punjab Algae.

Species of *Surirella* which are also common in other districts have not been found in Lahore, whereas species of *Rhopalodia* and *Epithemia* were obtained only from Lahore and its outskirts.

It is of interest to note that species of *Asterionella* and *Tabellaria* which are so prevalent in Europe have not been so far found in the Punjab.

2. The study of the Diatoms in India.

K. BISWAS, Calcutta.

In attempting to study the Diatom flora of this country the author felt first of all handicapped as usual for want of literature. This has been overcome to a considerable extent due to the author's having at his disposal the splendid library of the Royal Botanic Garden and obtaining advantages of literature available in other libraries in Calcutta. But the need of a list of published Indian Diatoms was realised for easy reference and I have therefore prepared a census of all genera published up till late years together with an estimate of total number of species under each genus in relation to those which are likely to occur in India. It has been estimated that only about 38 genera and 164 species of Diatoms have been reported from India, Burma, and Ceylon up till now out of 133 genera whose representatives are likely to occur in India. Of these 133 genera 5,750 species have been recognised. Thus less than about 3 per cent. of the species of Diatoms are known from India. But considering the vast coastline and climatic conditions of our country I may reasonably expect at least 25 per cent. of the species to occur in India. The writer's observations on the ecology of freshwater and brackish water Bacillariophyta have also been dealt with briefly in this paper.

3. On a new species of *Gomphonema*.

A. MAJEED, Lahore.

The writer has found a new species of *Gomphonema* growing as an epiphyte on aquatic plants in the tanks of the Shalimar Garden, Lahore. It differs from the other species in many respects, especially in (1) the gibbous middle region and narrow base, (2) apex pinhead-like, (3) striae

parallel, but slightly converging in the middle, (4) narrow axial area with stigma quite apparent, (5) individuals occurring singly, in twos or in threes on mucilaginous hyaline stalks.

4. A note on the peculiar movement of a species of *Navicula*.

A. MAJEED, Lahore.

This species occurs in abundance in the Punjab and is extremely interesting. The individuals exhibit peculiar movements when fresh material is examined under the microscope. Some (3 or 4) arrange themselves in an irregular zig-zag line, which after a few seconds breaks up to form a star-like figure. The motion is always accompanied by jerks. The movement has not been studied in full detail, therefore no explanation can be put forward at present.

5. On a collection of Algae from the Salt Range, Punjab.

S. L. GHOSE *and* ABDUL MAJEED, Lahore.

The collection was made by Drs. S. L. Hora and H. S. Pruthi, and kindly lent to us for examination. Samples were taken from nine different stations on a stream of water gradually increasing in salinity. At one end of the stream the water was absolutely fresh and drinkable; it showed a large number of species of Algae, belonging to the genera *Spirogyra*, *Oedogonium*, *Cosmarium*, *Cymbella*, *Denticula*, *Gomphonema*, *Navicula*, *Rhopalodia*, *Synedra*, *Nitzschia*, *Chroococcus*, and *Homoeothrix*, while in very salty places only species of *Enteromorpha*, *Chaetomorpha* and *Cocconeis* seem to flourish. A list of species found at different stations is given in the paper.

6. Notes on a collection of Algae from Shillong.

K. BISWAS, Calcutta.

Dr. S. P. Agharkar during his botanical excursions in Shillong and Cherrapunji in the beginning of October, 1925, made a small collection of mostly blue-green algae of sub-aerial habit and a bottle of preserved material of what appeared then to be a species of *Batrachospermum* and was kind enough to place his gathering at my disposal.

The following remarks have been made by Dr. Agharkar on the nature of the habitat of these algae :—

'The Cyanophyceae form a fairly thick matted felt at the base of a number of species of phanerogams which form an association which is found to be characteristic of the flat plateau-like portions surrounding the dâk bungalow at Cherrapunji and elsewhere. The phanerogamic species are very varied and are mainly composed of some grasses together with two species of Eriocaulon, one species of Xyris, two species of Impatiens, and two species of Utricularia (one yellow flowered and the second rose coloured flowers and others).'

The blue-green algae were alive and were soon placed in suitable media for culture. Within a short time beautiful growth was observed and without much difficulty about a dozen algae were separated from the beds. Among these, *Lyngbya trunicola* Ghose, var. *Burmense* Ghose, mixed with *Microcoleus chthonoplastes* gathered from a meadow in Shillong were present. The preserved specimen of the freshwater Rhodophyceae collected from the Crinoline Falls at Shillong proved to be of particular interest to me as it represents, perhaps, a new species of *Sirodotia* a more primitive genus than *Batrachospermum* bearing, however, a close morphological relation with it. Up till now only a few species of this genus have been recorded, mostly by Dr. H. Skuja of Latvia University. This

species was established by Kylin in 1912. The sub-aerial Algae of Cherrapunji were collected mostly from a flat meadow at a height of 4,000 ft. on the top of a hill and they illustrate the usual nature of their occurrence. Thus in Cherrapunji *Lyngbya aerugineo-coerulea. Porpherosiphon Notarisia* with its well marked pink sheaths and an interesting specimen of *Schizothrix* (cf.) *thelephoroides* and other members of *Scytonemateceae* evidently formed a mixed association. *Stigonema aerugineum* was observed to spread as a carpet on the ground and its growth in the culture too was pronounced within a few days.

7. A short note on soil Algae.

GURCHURN SINGH, Lahore.

The cultures were set up in small conical flasks. In each flask Bristol's culture medium was introduced to a depth of about ¾ of an inch and a few grams of the soil were also introduced by means of a sterile spatula. These flasks were placed in a glass box and exposed to diffused light. The green scum appeared after a month.

Following algae were isolated and described.

Gloeothece membranacea.
Aphanocapasa virescens.
Chroococcus minutus.
Camptothrix repens.
Nostoc sp.
Oscillatoria sp.
Protococcus viridis.

8. Some members of Codiaceae from Pamban.

L. N. RAO, Bangalore.

During September 1930, several specimens of Codiaceae were collected, some of them in excellent condition of growth and belonging to three different families. Since their occurrence has not been reported from this group of islands, an account of their distribution, habit and structure of the thallus is given. The chief forms dealt with in the paper are species of Udotea, Penicillus and Aurainvillea.

(Specimens were exhibited at the time of the meeting.)

9. Contribution to our knowledge of Indian Algae IV. Systematic and morphological studies in Zygnema.

R. L. NIRULA *and* P. L. ANAND, Lahore.

Collections have been made from Lahore, Nagpur and Tibet. So far about half a dozen species have been described. Some species show the formation of only parthenospores. In others distinct lateral or scalariform type of conjugation has been observed, the zygote being always formed in the conjugation canal.

A very interesting observation has been made in one of the species which shows both the scalariform and lateral types of conjugation side by side in the same filament. This observation is rather important since the classification of Zygnema is chiefly based on the two types of conjugation. A full discussion on its bearing on classification is given.

10. A species of Dichotomosiphon from the Punjab.

M. C. SETHI *and* R. P. SHOURI, Lahore.

Collected from Topi Park, Rawalpindi; attached to stones in large tufts. Branching, though clearly dichotomous, sometimes three branches are given, specially in connection with sex organs. Oogonia and antheridia develop on the same branch. The oogonia are terminally formed and the antheridia laterally. Tubers or asexual spores are not seen.

11. Monostroma sp.

M. C. Sethi *and* R. P. Shouri, Lahore.

A species of Monostroma (probably a new one) from Kashmir is described. Many of the thalli examined show tube-like structures containing a Crustacean.

12. Preliminary survey of the algal vegetation at Dwarka.

H. P. Chowdhury, Lucknow.

Dwarka is very rich in marine algal vegetation. A large collection of it has been taken away by Borgessen who is at present working on it. He has recently brought out a paper dealing with the Chlorophyceae and Phaeophyceae from the shores of the Presidency of Bombay and his paper on the Rhodophyceae has probably by this time come out.

A trip was made in January, 1930, with a party of post-graduate students and a collection was made of some of the littoral forms or forms washed ashore. The collection was hurried as the time at our disposal was very short. The following have so far been identified. The determination of species is extremely difficult without the help of proper literature and type specimens, and has been in most instances left over to be completed whenever facilities are available.

Phaeophyceae.

Colpomenia stellata.	*Ectocarpus Mitchellae.*
Sargassum sp.	*Hydroclathrus Cancellatus.*
Eudesme sp.	*Padina Commersonii.*

Rhodophyceae.

Polysiphonia—several species.	? *Grateloupia sp.*
Champia sp.	*Liagora sp.*
Rhodymenia sp.	*Hypnea musciformis.*
Chrysomenia uvaria.	? *Griffithsia sp.*
Phyllophora sp.	*Lithothamnion sp.*
Chondria sp.	*Gracilaria sp.*
Scinaia sp.	*Laurencia sp.*
Amphiroa sp.	*Asparogopsis sp.*
Halymenia sp.	*Galaxaura sp.*
Gelidium sp.	*Leveillea jungermannioides.*

BACTERIA, FUNGI, AND LICHENS.

13. Citrus canker, due to *Pseudomonas citri*, in the Punjab.

D. S. Johar, Lahore.

Citrus canker is one of the most destructive diseases noticed in the citrus fruit gardens. Malta, lime, orange and lemon plants are all susceptible to this disease. It is a bacterial disease caused by *Pseudomonas citri*. The canker spots on leaves and twigs and fruits have a glazed margin with an oily appearance surrounding the eruption and a crater like appearance which is noticeable with a hand lens.

The causal organism was isolated from the citrus canker lesions from the leaves, twigs and fruits on the sterilised potato chips. The characteristic yellow colour with a white margin of the culture is diagnostic test for the organism.

Inoculation tests were done on the young orange, malta, lemon and lime plants in the Government Lawrence Garden nurseries. Cankerous spots appeared within twelve days. On fruits of lemon, orange, malta the

spots appear on the surface without causing any actual rot and so impair the market value only.

The affected plants were sprayed with Bordeaux mixture (4 : 4 : 50 and 3 : 3 : 50) and also with Bordeaux oil emulsion. The stronger Bordeaux and the emulsion prevented further spread of the cankerous spots that season.

14. On *Clostridium Pasteurianum.*

J. Sen Gupta, Calcutta.

Raw cultures were made in suitable culture solutions from samples of soil from Calcutta and suburbs and *Clostridium Pasteurianum* obtained.

Potatoes inoculated with the samples of soil produced a rich growth of Bacillus Amylobacter (*Clostridium Pasteurianum*).

Pure cultures were obtained in solid media under anaerobic conditions and the different stages studied.

15. Myxobacteriaceae. Note on a species of Myxococcus found in Lucknow.

H. P. Chowdhury, Lucknow.

Mention is made for the first time of a species of Myxococcus found accidentally growing on horse-dung left for the culture of Pilobolus. It has a small almost a globate structure of about a mm. in diameter orange coloured or bright yellow in colour. It does not seem to be any of the species mentioned by Thaxter in his papers.

Whether it is a new species or an old one remains to be seen when further literature is available.

16. Morphological and physiological characters of the root-nodule organisms of a few leguminous plants of Lahore.

R. C. Sawhney, Lahore.

Organisms from the nodules of five species, viz., *Melilotus indica*, *Medicago denticulata*, *Trigonella faenum-graecum*, *Lathyrus aphaca*, and *Albizzia lebbek* were isolated in pure cultures and studied.

Organisms can grow on a large number of media but yeast-water mannite agar (Waksman), with pH value fixed at 6·8 is the most suitable. All the five strains agree very closely in cultural characters with each other. The efficiency of different media for the growth of nodule organisms was studied. Yeast-water mannite agar is the most and Richardson's medium the least efficient.

In pure cultures all the five strains form minute short rods which divide rapidly by binary fission. Involution forms so common in the nodule were not observed in pure cultures. Flagellation is monotrichic in *Albizzia lebbek* strain, the single flagellum being attached to one corner of the rod.

All the five strains liquefy gelatine and coagulate milk. None decolourizes vital red or forms gas either with Lactose or Dextrose. *Albizzia lebbek* and *Lathyrus aphaca* strains form copious amount of gum in liquid bean extract culture. *Albizzia lebbek* strain also forms gum but not in so large a quantity. Upper thermal death point for *Melilotus indica* strain was found to lie between 55° and 56°C.

Cultural, morphological and physiological characters of the organisms do not justify their separation into different groups.

17. Cross-inoculation studies with the root-nodule organisms of a few leguminous plants of Lahore.

R. C. SAWHNEY, Lahore.

Sand and agar culture methods were employed for growing plants for inoculation experiments. The technique in both cases was much improved. Inoculations were always carried in lots of ten.

Each of the three strains from the three species of Trifolas (?) (viz., *Melilotus indica*, *Medicago denticulata* and *Trigonella faenumgraecum*) forms nodules with the other two species besides its own parent. Results of cross-inoculation experiments, therefore, confirm the conclusions from morphological and physiological studies as far as these three species are concerned.

Our conclusions, however, have to be modified in respect of other two strains. *Albizzia lebbek* strain does not form nodules with *Lathyrus aphaca* or Trifolae and *Lathyrus aphaca* strain does not form nodules with *Albizzia lebbek.*

18. A luminous Agaric from South Burma.

S. R. BOSE, Calcutta.

Pieces of luminous wood obtained from South Burma gave rise to a small luminous Agaric *Pleurotus Sp.* It does not exactly agree with description of luminous *Pleurotus* reported so far by Molisch, Kawamura, and Buller. The cap with both the surfaces and the stalk were brightly luminous all over. It gave rise to soft white light. The hyphae in the wood were luminous also. This, the author thinks, is the first record of an Agaric where the vegetative mycelium and the whole sporophore with both the surfaces of the cap and the stalk were all luminous.

19. Cytology of secondary spore-formation in Ganoderma.

S. R. BOSE, Calcutta.

At the Allahabad sitting of the Indian Science Congress the author had reported the occurrence of secondary spores in Ganoderma direct from the tramalhyphae. The results of cytological study show that the hyphae which bear the secondary spores are binucleate, the two nuclei in the hyphae fuse into one fusion-nucleus, which fragments usually into two or three chromatin pieces, which pass out of the hyphae into the terminal spore, where finally the nucleus of the spore is constructed from these chromatin fragments. So, it seems to be a case of amitosis.

20. *Polyporus zonalis* Berk, and its effect on bamboo.

S. R. SEN GUPTA, Calcutta.

Polyporus zonalis is a common tropical fungus growing on dead decaying stumps of bamboo. The sporophore appears at the end of June, attains full development in course of a month and disappears ultimately in October. The first sign of rot is the appearance of isolated white areas which gradually unite to form longitudinal strips while the wood is rendered into a soft spongy mass. The hyphae within the host differ considerably from those of the sporophore and usually penetrate the cells through the pits. Clump connections are of frequent occurrence. The action of the fungus is one of delignification and absorption of starch grains from the cells of the host. The nature of the fungus whether purely a saprophyte or facultive parasite deserves to be investigated.

21. Fungus flora of Lahore soils.

GURCHURN SINGH, Lahore.

A study of the fungus flora of Lahore soils was made from October, 1930 to July, 1931. Different samples from field, garden, alkaline and humus soils were examined.

The following 32 species were isolated and described :—

Rhizopus sp. No. 1, *Rhizopus arrhizus*, *Mucor circinelloides*, *Cunninghamella verticillata*, *Monilia koningi*, *Cephalosporium n. sp.*, *Trichoderma koningi*, *Aspergillus fumigatus* (two strains), *Aspergillus nidulans* (two strains) *Aspergillus niger*, *Aspergillus calyptratus*, *Aspergillus terreus*, *Aspergillus n. sp. (DX)*, *Aspergillus flavipes*, *Aspergillus sydowi*, *Aspergillus versicolor*, *Aspergillus candidus*, *Aspergillus n. sp.* (*H*.3), *Penicillium terrestre*, *Penicillium pinophilum*, *Penicillium sp.* (*P. l.*), *Spicaria silvatica*, *Cephalothecium rosem*, *Glaeosporium herbarum*, *Helminthosporium sp.*, *Acrothecium lunatum*, *Alternaria humicola*, *Fusarium oxysporum*, *Fusarium sp. No.* 1, *Dictyochaete sp.*, *Stemmaria sp.*, *Hypha sp.*

The number of fungi, per gram of the soil, was counted. The number was highest in the case of humus soil. The season seemed to show no effect upon the number of fungi in the soil, though it was very slightly less in the hot months of July.

22. A study of the cellulose decomposing power of soil fungi.

GURCHURN SINGH, Lahore.

Different soil fungi were inoculated on McBeth's ammonium sulphate cellulose-agar and the plates were incubated for 27 days at 27–30°C. Following result was obtained :—

(+) sign designates the positive result.
(−) sign designates the negative result.

Aspergillus calyptratus	+
,, terreus	+
,, flavipes	−
,, (DX) n. sp.	+
,, candidus	−
,, niger	+
,, versicolor	+
,, fumigatus	+
,, nidulans	+
,, sydowi	+
,, n. sp. (H.3)	+
Mucor circinelloides	−
Cunninghamella verticillata	−
Trichorderma köningi	+
Monilia köningi	+
Spicaria silvatica	−
Fusarium sp. No. 1	+
Fusarium ovysporum	+
Rhizopus sp. No. 1	−
,, arrhizus.	−
Alternaria humicola	+
Cephalothecium roseum	+
Penicillium terrestre	+
Penicillium pinophilum	+
Penicillium sp. (P.1)	+

23. Fungus flora of Lucknow.

H. P. CHOWDHURY, Lucknow.

Attempts are being made to collect the materials of fungi found in or near about Lucknow. Most of the forms which have been found have

been mentioned by Kanhaiya Lal and Mitter and Tandon in their Fungus flora of Allahabad. A few of the forms found here, and which have not been mentioned by them, are given here :—

1. Trametes sp.
2. Hexagonia sp.
3. Fistulina sp.
4. Lenzites—several species.
5. Polystictus sanguinea.
6. Lepiota sp.
7. Pleurotus sp.
8. Lentinus sp.
9. Podaxis carcinomalis.

24. The occurrence of *Phytophthora parasitica* Dast. on *Boucerosia diffusa* Wright.

S. P. Agharkar *and* S. N. Banerjee, Calcutta.

In July, 1930, it was noticed that several branches of *Boucerosia diffusa* plants growing in pots in the garden of the Botanical Laboratory, Calcutta University, had died owing to their being affected by a sort of soft rot. The rot either extended from the base of the stems above ground level upwards or from above downwards reducing the stem tissue to a watery putrefying mass. The affected portions had a brownish-black colour. On investigation the causal organism was found to be *Phytophthora parasitica* Dast. The fungus in question was brought into pure culture and was grown on various media. Morphologically this strain agreed closely with Dastur's description of *Phytophthora parasitica*, the only difference being that in this strain the sporangia were relatively broader. The size of chlamydospores was in agreement with those of *Phytophthora parasitica typica*.

Infection occurs through wounds only. Details of infection experiments have been given.

25. *Fusarium sp.* causing disease of *Eichhornia crassipes* Solms.

S. P. Agharkar *and* S. N. Banerjee, Calcutta.

The leaves of water hyacinth are often found to be covered with yellowish-brown to reddish-brown spots on the petioles. The spots are caused by a *Fusarium sp.* which has been studied in pure culture in various media. The diseased leaves are at first sickly yellow, shrivel up with the progress of the disease, and finally droop downwards. Both micro- and macroconidia have been obtained in abundance. Inoculation experiments are being made. The infection takes place readily, but owing to the high resisting power of the plant, the disease makes very slow progress. From this it may be inferred that this fungus cannot be regarded as a possible remedy against the spread of water hyacinth.

26. Preliminary observations on *Cercospora euphorbiae* Kell and Swin.

V. N. Likhite, Baroda.

Euphorbia nerifolia is a very common hedge plant in Gujrat. Its growth of internodes is annual on which also the seasonal involucre of leaves is borne. In August many of these plants are attacked by a leaf fungus *Cercospora euphorbiae.*

The infection begins with a minute crimson spot, conspicuous to the naked eye and the parasite grows in concentric rings. As the growth advances a dark pad is produced by the parasite and the middle portion of this pad subsequently gets dried. Some time a shot hole is thus produced. The surrounding portion of this pad may continue to be crimson for a long time. Though the pad is rather skinny and though two or three spots are sometimes united.

Kept under a moist chamber or under the condition of a good rainfall when the atmosphere is moist, there appear the typical conideae of *Cercospora* on it. These to the unaided eye are a velvety whitish growth. The length of the conideae varies between 10μ—30μ and are generally seven septate.

Cultures were done.

27. Further studies on 'green-ear' of Bajra.

H. CHAUDHURI, Lahore.

Unusual formation of green-ear twice over in the same plant, viz., once in the beginning and once again later in the season has been noticed. New green-ears are formed in the axils of the old ones. Only oospores have been found on Bajra in the Punjab. Absence of conidial stage has been ascribed to low humidity of the atmosphere. Successful inoculation experiments have been performed on Bajra with oospores of previous season's crop. Though no green-ears were formed on inoculated plants, the leaves showed usual shredding and were full of oospores.

Oospores of Bajra Sclerospora have been germinated successfully for the first time in India following Hiura's method. It has also been found that even five years old oospores retain their viability under laboratory conditions. As oospores from the sporangial stages when present have been definitely proved to be incapable of infecting other Bajra plants, this germination of oospores and their long viability and also successful inoculation experiments show beyond doubt that the disease is propagated through the oospores in the soil.

28. *Fomes leucophaeus* Mont, on Spiraea.

H. CHAUDHURI, Lahore.

Some plants of Spiraea 4–6 ft. high were found dying in a Lahore garden. They were gradually drying up from the tip downwards. Leaves and twigs showed no diseased organisms. On uprooting a plant, the stump below the soil level was found to have been attacked by a fungus which caused destruction of the stump in a ring form. Only fungal hyphae were found. Sterilised bits of woods in test tubes were inoculated. Slides showing the presence of the fungus in the host tissue and destruction of the cells have been made. No fructifications were formed in the culture tubes, beyond formation of knots of hyphae but the bits of woods inoculated became soft and pulpy. In one of the plants, later on, the fructification of the fungus appeared and was found to be that of *Fomes leucophaeus*. The author is indebted to Dr. S. R. Bose for the specific identification.

29. A case of penicilloid type of conidiophores in *Aspergillus nidulans*.

H. CHAUDHURI, Lahore.

This was a fruiting form which had saltated from an old Aspergillus culture. The most interesting thing about conidiophore formation was that on the same mycelium not only aspergilloid types of conidiophores but also penicilloid types of conidiophores were formed. Drawings are given, showing that on the germination of a single conidium which produced two germ tubes, from one a fertile branch inflated at the apex bearing chains of conidia on sterigmata like any typical Aspergillus is formed while from the other germ tube, a fertile branch, not at all inflated but typically branched like a Penicillium and bearing chains of conidia developed; intermediate forms are also shown which developed from single spore cultures in hanging drops.

These occurrences show the futility of artificial classification of Aspergillus and Penicillium in their imperfect forms.

30. Notes on a Cordyceps from Tibet.

H. Chaudhuri, Lahore.

Prof. Kashyap brought these specimens from Yatung in Eastern Tibet. They are locally known as Yartsa Gungbu—'in spring grass, in winter worm', and are used as valuable medicine by the Chinese.

It consists of a rigid sterile tip, then the fertile portion (perithecial clava) and below the barren portion (stalk). The perithecia are superficial and are distributed all over the cylindric head. The perithecia are dark brown when dry and are loosely adherent to one another at the base. The asci are cylindric and each ascus contains eight filiform, hyaline and multiseptate ascospores. It very much resembles the Chinese species *C. sinensis.*

31. Study of *Cladosporium herbarum* on *Pisum sativum.*

A. H. Sheikh, Lahore.

It produces blackish irregular spots on the surface of the pods. In younger pods, the disease produces contortion and bending and if very young the affected pods shrivel and dry up.

The causal organism has been isolated and the morphological characters of the fungus, its effect on the host cells as well as the physiology of the fungus in different cultural media have been studied. Pathogenicity of the fungus has been proved by inoculation experiments.

32. Study of the gram blight caused by *Ascochyta pisi.*

A. H. Sheikh, Lahore.

Gram blight causes heavy loss annually at Campbellpur. Recently it has been reported from Lyallpur also.

Almost all green parts of the plant are affected. Leaves are first attacked and later the stem, petioles, pedicels, pods and lastly the seeds are affected. The spots are round, oval or elongated and dark brown in colour. The pycnidia are concentrically arranged in the centre of the spots.

Seeds become smaller and in very severe infections they are not formed at all. It has been found to be caused by *Ascochyta pisi.*

Cultural study of the fungus has been made. In addition to pycnidia, chlamydospores and hypnocysts are formed by the fungus. The mode of development of the pycnidium has been studied and described.

Inoculation experiments with *A. pisi* from culture failed to produce spots in any other parts of the plant excepting the leaves.

33. Some diseases of the cotton plants of the Punjab.

Md. Shafi, Lahore.

In this paper the damping-off of cotton seedlings due to *Fusarium sp.*, Sooty mildew due to *Capnodium sp.*, Leaf spot caused by *Mycosphaerella gossypina* and areolate mildew due to *Ramularia areola* have been described. Details regarding mode of infection life-history of the fungus and growth in culture are given.

34. Studies in physiology of *Fusarium sp.* from cotton.

Md. Shafi, Lahore.

It has been shown that formation of one or both types of spores depends upon the medium in which it is grown. Both micro and macroconidia are formed on Czapek's, Cook's, and potato glucose agar, while

on bean-agar, gram-agar, glucose agar, only microconidia are developed. Cross inoculation from bean-agar into Czapek's and from Czapek's into bean-agar, resulted in the formation of both types of spores in the former and only microconidia in the latter. Again on fresh potato slices both types of spores are formed, while on cooked potatoes only microconidia developed.

35. Angular leaf spot of Cotton.

MD. SHAFI, Lahore.

This is caused by *Bacterium malvacearum*. It has noticed only on American and Sea-Islands cotton but not on Desi cotton. Cotyledons, leaves and bolls are attacked but the leaves suffer most. First symptom of the disease is the appearance of angular water soaked areas; later the spots increase in size and become brown in colour; in the last stage the affected spots become papery but do not fall off.

The causal organism has been isolated and successful inoculation experiments have been performed. Seedlings grown from sterilised cotton seeds did not show infection but only those from unsterilised seeds showed infection. The organisms are carried in the fuzz. Affected leaves gradually wither and fall off prematurely.

36. Study in artificial culture of some Alternarias of the Punjab.

J. C. LUTHRA *and* KRATAR SINGH, Lyallpur.

Alternarias from 24 hosts have been described from nature and behaviour in culture of a number of them has been studied. Excepting Alternaria from *Surkha*, (a potato variety) others are more or less non-chromogenic.

Pathogenicity of Alternaria from wheat, sugarcane, calotropis and Datura has been proved. Frequency tables showing the spore measurements of different Alternarias from nature and artificial cultures have been made.

37. A study of variation found on *Alternaria brassicae* (Berk) Bolle.

J. C. LUTHRA *and* L. S. BHANDARI, Lyallpur.

Long spored Alternaria from 7 Cruciferae hosts and small spored Alternaria from 2 hosts have been studied. Differences exist between the 7 long spored Alternarias on their hosts as regards colour and size of their lesions and time of infection. These variations are due to environment and may be termed as modifications.

Small spored Alternaria from Cauliflower produce a chromogenic saltant on leaf decoctions and rice meal agar. The saltant loses its chromogeny on synthetic media in the first generation and on plant decoction in the third generation. This gradual reversion of the saltant to the parent type is an example of temporary variation and may be termed as fluctuation.

Long spored Alternarias isolated from 7 different Cruciferae hosts behave as 2 distinct strains on synthetic media. One of these from rape saltates on plant decoctions producing a strain which has poorly developed aerial mycelium, slow rate of growth, and low vitality as compared with the parent.

A further cultural study of the three long spored Alternarias, viz., 2 original strains (called A and B) and the saltant (C) has been made. It was found that they differ from one another in macroscopic, microscopic, and physiological characters. They have been grown in culture for

about 10 generations and they maintained these differences and C has never been found to revert back to B. No variation was found in the degree of virulence. It is concluded that the three strains of long spored Alternaria are different physiological forms of *Alternaria brassicae* (Berk) Bolle, and the small spored *Alternaria circinans* is quite a different species.

38. Sugarcane Colletotrichum.

J. C. LUTHRA *and* KRATAR SINGH, Lyallpur.

Colletotrichum falcatum Went which causes Red Rot of sugarcane in the Punjab, is a polymorphic species and consists of at least three physiological forms. The differences of the forms are more pronounced when growing on certain media only. Nutrient glucose agar has been found to be the best differentiating medium for identification of the three forms.

Comparative cultural tests during the course of investigation indicate that the physiological forms remain constant and always appear to be the same under identical conditions. Repeated inoculations and cross-inoculations have been made and the results have been consistent. Differences between the forms are scarcely pronounced enough to consider them as separate species, hence they are considered by the writers as physiological forms of *Colletotrichum falcatum* Went.

39. Red rot of Grape vines.

J. C. LUTHRA *and* L. S. BHANDARI, Lyallpur.

A new disease of grapes caused by *Gloeosporium rufomaculans* Berk Thum. has been described. Symptoms of the disease are the production of tumours and cankers on shoots, and reddish brown spots on grape berries. The shoots dry and nearly all the tissues are involved in canker formation. The xylem vessels are badly affected, as they become compressed, distorted and get choked by hyphae. Hence they fail to carry on their function properly and branches dry. The pathogenicity of the fungus has been established by making inoculations on branches, leaves and grape berries by pricking.

'Red rot of grapes' is suggested as the name of this disease. The behaviour of the fungus under different cultural conditions has been studied. Conidia germinate within 4½ hours. After germination, they produce 1 or 2 germ tubes each from one end, become uniseptate and produce appressoria. The fungus is very viable. Spores from dried branches 8 months old germinated and formed acervuli after 2 or 3 days. Overwintering is perhaps done in this way. Under conditions of high humidity it produces enormous quantities of conidia. Copper sulphate even in small concentrations, i.e., 0·1 per cent. was found to be toxic for its growth in culture.

40. Grey blight of tea due to *Pestalozza theae* Sowada.

V. S. KAPUR, Lahore.

The disease is very common in Palampur plantations and its suburbs. In Holta plantation—the biggest tea estate towards that side—90 per cent. of the bushes are affected by it. It causes a great economic loss to the tea industry by reducing the amount of leaf which can be utilised in the production of tea. It appears as brownish spots which later on increase in size and ultimately turn grey. On these greyish patches numerous black dot-like structures are seen. These are pycnidia which are bowl-shaped. Inside are numerous characteristic spores (stalked, fusiform, 5 celled, 3 middle cells coloured while two end cells are hyaline,

the upper hyaline cell possessing 3 hyaline, filiform appendages). Germ tube arises from the third coloured cell but it may arise from other coloured cells also. The physiology of the fungus has been studied. Inoculations with the causal organism produced grey blight. Brown spots appeared after a week and in about 8 weeks time, these formed patches.

41. Brown spot disease due to *Phoma theicola* Petch.

V. S. Kapur, Lahore.

This disease is not of common occurrence. The attack of the fungus is not so severe as in grey blight. The disease appears as minute brownish spots which increase in size and coalesce to form bigger spots. Later on pycnidia appear as minute elevated dots on both the surfaces. Pycnidia are sub-globose and open through ostioles which are the characteristic feature of the fungus.

Spores are oval, hyaline and non-septate. The character of the fungus under different physiological conditions has been studied, as well as inoculation experiments performed.

42. A study of pycnidial formation in *Phoma theicola* Petch.

V. S. Kapur, Lahore.

Development takes place in a meristogenous manner, one or more cells of a hypha become more pronounced and later divide to form a knot. This increases in size by divisions in various directions. Later on branches are given out from some of the outermost cells. A protuberance which is at first colourless grows out which ultimately develops into an ostiole. This is the primordium from which pycnidium arises. The radiating hyphae probably supply the primordium with nourishment. Microtomic sections of the diseased spots also showed various stages of development. If the pycnidia are placed in water they liberate long coils of mucilage in which numerous spores are embedded.

Effect of different concentrations of media, light, aeration, etc., has been studied. Pycnidia are numerous and early formed in lower concentrations while few are formed very late in higher concentrations. The pycnidial formation is not dependent on light as in other sphaeropsidales. They are also abundantly formed in darkness. Regarding aeration it has been shown that lack of oxygen inhibits pycnidial formation.

43. A study of the wilt disease of tomato plants caused by a *Cephalosporium sp.*

Mohammad Aslam, Lahore.

The wilt disease of tomato plants caused by a *Cephalosporium sp.* is described. Due to its attack the leaves dry up and the stems are discoloured as if insufficiently supplied with water. At a later stage the plants completely lose their vitality and collapse. The stems become hollow and are filled with mycelium partially in the form of fluffy grey mould. Spores are found on the host plant. These are hyaline, septate, oval and are produced on conidiophores. The mode of development of conidia as also germination of the conidia have been described. Physiology of the fungus has been studied. Effect of different concentrations of media, aeration, light, temperature has been followed. It has been observed from inoculation experiments that the fungus is a soil-dweller and that infection takes place through roots or through wounds in aerial parts of the stem. The infection is completed between 30 and 40 days.

Section of Anthropology.

Papers.

44. Fusarium wilt of potatoes.

MURARI LAL, Lahore.

Wilting of potato plants due to an attack of *Fusarium sp.* occurred in Government College Botanic Garden, Lahore. Both macro and microconidia are produced. In addition to these chlamydospores are formed within the hyphae. Sporodochia are present. Physiology of the fungus was studied. The upper thermal death point of the fungus was found to be 57°C. Inoculation experiments were successful and wilting was noted in inoculated plants. The browning and blackening of the stem was found to be due to toxic substance secreted by the fungus.

45. Pink rot of apple.

MURARI LAL, Lahore.

The pink rot disease on apples imported here from Kulu due to *Cephalothecium roseum* Corda has been studied. The morphological characters of the fungus have been studied and described. The causal organism has been isolated. The growth characters of the fungus on various vegetable and synthetic media have been studied and the effect of different concentrations of Czapek's medium has also been studied. No effect of light on the growth of the fungus is noticed. The upper thermal death point of the fungus was found to be 51°C. The writer was able to observe artificial infection in case of Desi and Kulu apples and small seedless variety of grapes.

46. Some new Lichens from the Sikkim Himalayas.

G. L. CHOPRA, Lahore.

The writer collected about 125 species of Lichens from Darjeeling and the Sikkim Himalayas during July, 1929-30. About 50 of these were studied by the writer during last year, and the abstracts contributed to the Nagpur Science Congress. The rest have been recently finished. The writer, however, is very much indebted to Miss Annie Lorrain Smith for confirming and verifying his determinations. Their study reveals them to be engrossingly interesting and the following are recorded to be new additions to the already known Lichens of the world :—

(1) *Anzia physoidea* A. L. Smith.
(2) *Bacidia nunana* A. Zahlb. *var.* rugosa, A. L. Smith.
(3) *Pyxine reterugella* Nyl. *var.* sublestacea, A. L. Smith.
(4) *Pyxine reterugella* Nyl. *var.* macrothecia, A. L. Smith.

47. Lichens from Simla.

G. L. CHOPRA, Lahore.

The Lichens from Simla and its suburbs were collected by the writer during September, 1931. The season being most suitable for collection, almost all the specimens were found bearing fructifications and hence facilitated their identification. About 65 species were collected in all. Of these 30 are different from those already described by the writer from the Eastern Himalayas.

48. Lichens from Vaishno Devi (Kashmir).

G. L. CHOPRA, Lahore.

The writer visited Vaishno Devi, a sacred temple of the Hindus about 30 miles from Jammu. It is situated at an elevation of about

9,000 ft. above sea level in the outer range of the North-West Himalayas. The vegetation is scanty on the exterior, but as the writer ascended higher and reached an elevation of 7,000 ft. in the interior, the oak forest appeared bedecked with all types of Lichens, e.g., foliose, fruticose and crustaceous. About 30 species were collected from this place. Of these, 10 are confined to this locality, not having so far been met with in other parts of the Himalayas visited by the writer.

BRYOPHYTES.

49. A study of the *Calycularia crispula* Mitten.

M. N. Nayar, Lahore.

The gametophyte of *Calycularia crispula* is thallose which branches dichotomously and possesses innovating lobes. The plants are dioecious and form separate patches. The male plants are smaller than the female plants. The midrib is thick and 10–15 cells in thickness which gradually thins out to one celled wing. The apical cell is of cylindric lenticular type but a few transitional forms have been observed. Ventral shoots are very common. On the ventral surface of the midrib are found amphigastria and smooth rhizoids which sometimes branch and bear knee like processes. Profuse presence of the mycorrhiza was noticed. The involucre and the perianth is one and the same thing and the latter is derived by the fusion of the former. Antheridia and archegonia are found on the dorsal surface in clusters near the growing region and at the junction of the lobes. They develop according to Jungermania type. About five abnormal archegonia were found which throw sufficient light on the origin of sex in Bryophyta.

The development of the egg and the sporogonium has been described.

Calycularia is a synthetic genus and the present writer has given it a suitable position in the proposed classification.

50. Vegetative propagation in Mosses, particularly two notable types: one in a Darjeeling species growing between 5,000 and 6,500 feet, and the other in a species growing on bark of trees within the area of Calcutta.

G. P. Majumdar, Calcutta.

Distribution through 'brood-bodies' (gemmae) is found to be fairly common in the mosses growing in and about Calcutta. Brood-bodies produced in the axils of leaves from the stem-cells as well as produced from the leaf-cells have also been observed in a few cases. Two species have been collected which show production of protonema in the axils of leaves.

In the species collected from Darjeeling, as in *Webera proligera* studied by Goebel, these organs are extremely suppressed shoots. Their shoot nature can be recognised only on a comparison with other species and also by their position on the main shoot. These peculiar brood-organs are filamentous, each consisting of two rows of cells spirally twisted and ending in an apical cell cutting on two sides only. This species is further characterised by the leaves, in the axils of which these organs are produced in numbers, aggregating into a *cone* (strobilus) which in the majority of cases is completely differentiated from the lower vegetative region. The specimen was found to be growing on bare rocks.

The epiphytic species collected in Calcutta shows the following peculiarities: (i) no sexual organs have so far been found; (ii) the leaves are of one kind and not differentiated into fertile and sterile as observed by Goebel in a similar case in *Calymperes Giesenhageni;* and (iii) the brood-bodies as in the above species are produced in tufts at the tip which is the thickened end of the midrib of each leaf.

51. Physiological anatomy of *Bryum roseum* Schreb.

S. C. BANERJI, Calcutta.

The species *Bryum roseum* Schreb. grows in dense mats on hill slopes in temperate conditions and was collected from the Elephant Falls near Shillong in December, 1929. The species has a tiered growth and bears three types of shoots according to variations in the water-supply. These are :—

(1) *Fertile shoots* with one tier bearing reproductive organs on the apex which is flat. These are found on the outskirts of the formation with a moderate water-supply. The archegonium has a long 6-7 celled neck and is articulated to a short column with a few paraphyses around the base simulating a flower.
(2) *Sterile shoots* with 3-4 tiers. These were found in the central regions of the formation where plenty of water collected. These are richly provided with rhizoids and their apex is convex and continues the tiered growth.
(3) *Very short fertile shoots* developed from a bud at the axil of a coronal leaf of a tier of the sterile shoot when its vegetative activity becomes arrested due to a reduction in the water-supply in the central portions of the formation, as during the winter season in December. The apex of these shoots is flat as in (1).

The leaves are of two kinds—cauline and coronal, the former are one layer of cells thick and the latter several layers along the middle, their configuration and correlation with the rhizoids ensure accumulation of water on the plant-body, and its ready absorption. This is very prominent in the sterile shoots. The stele and leaf-traces are very prominent.

PTERIDOPHYTES.

52. Apogamy in some Indian Ferns.

P. N. MEHRA, Lahore.

Pure cultures of *Pteris biaurita*, *Adiantum lunulatum*, and *Cyrtomium falcatum* were raised from spores along with that of other ferns collected from various places and all stages from the germination to the mature prothallus studied. Apogamy has been observed in the above mentioned three species.

Pteris biaurita.—The two lobes of the cordate prothallus are not of the same age as in *Pteris longifolia* and *Ceropteris calomelanos*. Sporophytic buds begin to develop in some cases even when there is no appearance of any sex organs but in other cases after the formation of antheredia. There is no appearance of any archegonia. The gametophyte remains only a single layer of cells in thickness—there being no formation of the true cushion—and just behind the notch the cells assume meristematic activity forming a sort of circular localised cushion wherefrom the cotyledon, the primary root, and the scales characteristic of the sporophyte are given off.

Adiantum lunulatum.—The two wings of the cordate prothallus are of equal age. Feeble collenchymatous thickenings occur at the corners of the prothallial cells. The usual cushion is formed upon which scattered antheridia only are borne, there being no trace of archegonia. Some cells of the cushion are elongated and among them may be found true annular xylem vessels scattered or having connection with the sporophytic bud developing just behind the notch. The bud is densly surrounded by characteristic scales of the sporophyte which resemble the similar scales in the sporophyte of *Adiantum capillis-veneris.*

Cyrtomium falcatum.—Two lobes of the cordate prothallus are of equal age and there is the development of cushion. Unicellular glands established as a character for the gametophytes of other species of the Dryopteroid series by the writer are present. Antheridia and archegonia develop in the usual way. The sporophyte has been observed to develop from the surface cells of the gametophyte without the intervention of archegonia. It could not be definitely ascertained whether in all cases the sporophyte develops apogamously but large numbers of quite barren archegonia were observed. True annular xylem vessels have been observed scattered in the general body of the prothallus. A most remarkable thing is the formation of loose tissue on the ventral surface of some prothallia.

Cytological investigation of the above three species is being carried on.

53. Collenchymatous thickening in some prothallia.

P. N. MEHRA, Lahore.

Prothallia of *Cheilanthes farinosa*, *Adiantum lunulatum*, *Adiantum caudatum*, *Adiantum capillis-veneris* and *Polystichum auriculatum* have been raised from spores collected from various localities. *Cheilanthes farinosa* shows very remarkable collenchymatous thickenings at the corners of the cells while *Polystichum auriculatum* and *Adiantum caudatum* show the same to a slightly smaller degree. *Adiantum lunulatum* shows rather feeble thickenings while they are altogether absent from *Adiantum capillis-veneris*. Such thickenings appear to be a feature of œcologic adaptation of the ferns to dry places since in the prothallia of ferns adapted to moist places they are not present. Dr. Horvat's interpretation of such thickenings as a character of phyletic importance of Gymnogrammoids does not hold good in view of such thickenings being absent from *A. capillis-veneris* prothallus—a Gymnogrammoid and its presence in *Polystichum auriculatum* belonging to Dryopteroids—quite different series.

54. Repeated dichotomies in the gametophyte of *Anisogonium esculentum.*

P. N. MEHRA, Lahore.

Prothallia of *Anisogonium esculentum* have been kept growing for a little more than two years. They have attained a large size and are repeatedly dichotomously divided. The gametophytes become dark green in colour and bear large number of archegonia. One prothallus was observed to be $1\frac{1}{2}'' \times 1\frac{1}{4}''$ in size showing 5 dichotomies. From external appearance it appeared to resemble more a thallose liverwort than a fern prothallus. This unusual growth is due to failure in fertilization of archegonia since the prothallus was at some distance from younger gametophytes bearing antheredia.

55. On the occurrence of superficial sori in *Osmunda Claytoniana.*

N. P. CHOWDHURY, Lucknow.

In some abnormal specimens of *O. Claytoniana* collected by Dr. Sahni at Gulmarg (Kashmir) the occasional presence of distinct sori on the abaxial surface of some pinnules (which were otherwise just like sterile pinnules), was noticed. Such pinnules bearing abaxial sori occurred only at the transitional region from the normal fertile to sterile part of the frond.

The sporangia are mostly arranged along two sides of some of the latteral veins to which they are attached by their thick stalks. In a few other pinnules peculiar linear thickenings were seen over a few lateral veins, which at certain places even bore one or two deformed sporangia. These thickenings are regarded as probably abnormally developed placentae of sori or fused masses of aborted sporangia. The author discusses the

bearing of these abnormalities, namely, the superficial position of sporangia and their arrangement in sori, on the question of the relatively primitive or advanced nature of such characters in *Osmunda*, and finally is of opinion that these abnormalities might possibly be of the nature of a reversion.

56. Proliferation of the cone in a species of *Selaginella* from Garhwal.

S. L. GHOSE, Lahore.

The plants were collected by Prof. Kashyap from the Alaknanda valley in Garhwal, about 8,000 ft. above the sea-level, and were kindly handed over to me for investigation. They belong to the sub-genus Stachygynandrum of *Selaginella*, having uniform bracts and ordinary leaves of two kinds and spreading in two planes, those of the upper plane being smaller and more ascending. In *Selaginella* as a rule the cone is terminal and unbranched. Miss Mitchell (*Annals of Botany*, Vol. XXIV, 1910, pp. 21-22), however, has described the following four variations from the normal type: (1) In *S. patula* and *S. cuspidata* 'beyond the fertile homophyllous cone the axis continues to grow vegetatively, reverting to the dorsiventral structure characteristic of the ordinary stem'. (2) In an unnamed species from India, probably *S. pennata*, the same phenomenon was observed 'save that abortive sporangia were produced in the axils of the vegetative leaves following the tip of the cone, illustrating the gradual transition between the purely sterile and entirely fertile regions'. (3) 'In *S. erythropus* a second cone was produced on a fertile branch after an intervening sterile region entirely devoid of any vestiges of sporangia; in other words, two definitely fertile regions occurred on the same branch'. (4) In *S. oregana* the strobilus is genuinely branched. There is a region with entirely aborted sporangia at the base of the branches but the leaves of this region retain the external form of sporophylls. A genuinely branched strobilus has also been described by the writer (*Journal of Bombay Natural History Society*, Vol. XXV, 1917, pp. 284-289) in *S. pallidissima*, in which upper sporophylls are usually sterile.

In the species described here in many cases the homophyllous cone continues to grow and may produce one or two cones in continuation or branch out into two cones at the tip. All these cones have a sterile region at the base, where in many cases the leaves show a clear tendency to revert to the dorsiventral arrangement characteristic of the vegetative region. Thus the abnormality here is of quite a different type from those already recorded and may be taken to combine all the four abnormalities mentioned by Miss Mitchell. The alternation of sterile and fertile zones 'suggests the condition normally occurring in the more primitive Lycopodiaceae'.

57. A note on sex-differentiation in the gametophyte of Equisetum.

V. G. PHATAK, Baroda.

The writer has discussed 'Sex differentiation in the gametophyte of the Genus Equisetum'. It may be possible that in the Genus E., or even in a species of E. that is very variable (according to present classification), a gradual scale of evolution may be found along which the typical hermaphrodite type gradually merged into the characteristic unisexual type. It appears to the writer that in the characteristic unisexual types, it may be that it is the constitution of the germplasm of the spore that is changed, and which appears not to have as yet affected its external form and structure.

It may be said, therefore, that plants producing spores that are morphologically as well as functionally homosporous, definitely stand on a lower stage of evolution as compared with plants producing spores that are morphologically homosporous but functionally heterosporous.

58. Prothallus formation in a species of Equisetum, growing at Pashan, Poona.

V. G. PHATAK, Baroda.

The writer has thoroughly worked the prothallus formation in a species of Equisetum growing at Pashan near Poona and has given all the stages in the prothallus formation together with their internal structure from the time the spores are shed over a germinating medium till the formation of an adult prothallus. In the earlier stages of development it is found that the prothallus assumes a form which is directly controlled by its position in a cluster of young prothallia. In the earlier stages of development male and female prothallia cannot be distinguished, but later on much branched and small males are clearly distinguished from the unbranched and circular large female prothallia. The prothallia are invariably unisexual being either pure males or pure females and never hermaphrodite whether grown in cluster or grown apart.

59. A note on the meristematic regions in the gametophyte of Equisetum.

V. G. PHATAK, Baroda.

The writer has enumerated some interesting features in connection with the meristematic region of the gametophyte of a species of Equisetum growing at Pashan near Poona. It is found that every cell in a young prothallus is really a meristematic cell and that a growing point is not restricted to any single cell which is either apical or intercallary. As the prothallus advances in age, most of the lower and central cells that are by now older, lose their meristematic capacity and it is being restricted to a circumferential ring towards the distal end of the thallus. The activity of these meristematic cells appear to be working in three different ways—(i) in the formation of the characteristic green lobes, (ii) in additions made to the thallus, (iii) in the development of sexual organs. In the lobes themselves, the meristematic activity is very short-lived and soon they become permanent tissue. It is only the male prothallus that is capable of producing new fertile branches. No such branches are to be met with in female prothallia.

It is thus clear then that there is no indication of any apical cell as we understand it for most of the Pteridophyta. It is a tissue made up of many cells which is responsible for growth as in the higher plants.

60. On the ventilating system of certain Indian ferns.

T. C. N. SINGH, Benares.

Air-spaces.—(*a*) The rhizome cortex of *Lastrea fuscipes* has a large number of intercellular spaces such that they are noticeable even with the naked eye as beautiful minute perforations.

(*b*) An interesting feature of the petiole of *Asplenium viride* Huds. is the presence of air-spaces in the ground tissue with the vascular bundle held up in the central position by bridges of trabaculae.

(*c*) In the petiole and rachis of *Asplenium alternans* Wall, two air-spaces make their appearance, one on the adaxial and the other on the abaxial side. The adaxial one soon closes up while the abaxial one furcates higher up into three and ultimately towards the extremity they fuse and close up altogether.

Loose-tissue.—On either side of the rachis (primary and secondary) of *Onychium auratum*, *Polystichum auriculatum* var. *caespitosum*, *Lastrea rigida* and *L. fuscipes* Wall. and the secondary rachis of *Polystichum aculeatum* Sw. and also var. *Rufo-barbatum*, below the epidermis is found a loose-tissue composed of thin-walled cells (with chlroplasts) like those of

the spongy mesophyll. It can be located externally by a ridge on either side of the rachis. The epidermis above this tissue is pierced by stomata. Such a tissue is noticeable even in the tertiary rachis of *Onychium auratum*.

The biological significance of these structures is discussed in the fuller paper.

61. The microsporangia of *Isoetes coromandelina.*

T. N. VENKATANATHAN, Madras.

The microsporangia (which are recorded for the first time) are of very rare occurrence. Following the plant throughout a single vegetative season, it was found that these are present only in a very few plants among the outer sporophylls formed early in the season. The number of these in such plants is very often one, rarely two. They always appear after a few megasporophylls are formed.

In spite of such rare occurrence it was possible to study, with the help of permanent preparations, the development of the microsporangia, including the reduction divisions of the microspore mother cells. After the sporangium had grown to a certain size, the uniform mass of sporogenous tissue is differentiated into sterile and fertile areas. The latter, by further divisions, gives rise to smaller groups of spore mother cells, which get rounded and separate from one another as the division progresses.

Preceding the two divisions in the mother cell a body appears in the cytoplasm which behaves similarly as the one in the megaspore mother cell (reported by me during the last session). Besides this prominent feature of the division a few other interesting points are noted in the division stages. The haploid chromosome number is determined to be 16 by the counts made in the bivalent stage and the heterotypic anaphase.

GYMNOSPERMS.

62. Fertilisation in Cycas circinalis.

M. A. SAMPATKUMARAN, Bangalore.

ANGIOSPERMS.

63. The Zephyr Lilies.

R. N. PARKER, Dehra Dun.

The Flora of British India mentions *Zephyranthes tubispatha* Herb. as cultivated in gardens and found as an escape. This species has however not been collected either wild or cultivated for the last 60 years. *Z. carinata* Herb. and *Z. rosea* Lindl. appear to be sparingly naturalized and *Z. candida* Herb. and *Z. citrina* Baker commonly cultivated.

64. Life-history of *Urginea indica.*

P. MAHESHWARI, Agra.

Urginea indica is a member of the family Lilliaceae, found wild in many parts of India. The development of the female gametophyte follows the normal course. The material is excellent for class use.

Usually one of the hypodermal cells of the nucellus enlarges to form the primary archesporial cell. This divides to form the primary wall cell and the megaspore mother cell. The former divides periclinally to form a wall two cells thick. The megaspore mother cell undergoes the usual reduction divisions to form a tetrad of megaspores, which may be linear or T-shaped. In most cases the lowest megaspore functions, though occasionally the first, second and third megaspores have also been found to

enlarge. Frequently two mother cells have been observed in the same nucellus. These may lie side by side or one above the other. Both may go through the reduction divisions simultaneously, but further development has not been observed. The nucleus of functioning megaspore divides to form two nuclei, these divide to form four, and these in turn form the eight nuclei of the normal embryosac. The two synergids are sister cells, and the egg and upper polar are sisters. The antipodals are ephemeral. The polar nuclei fuse to form a large fusion nucleus which lies in the lower part of the embryosac.

Further work is in progress.

65. Studies in the cytology of the Liliaceae. I. Somatic cell division in *Aloe vera* L.

R. N. SUTARIA, Ahmedabad.

The number of somatic chromosomes in *Aloe vera* is fourteen. They are of unequal size—eight large and six small. When these fourteen chromosomes are arranged on the equatorial plate of the bipolar spindle, some of them show a longitudinal split. Each of the eight large chromosomes bears a sub-terminal constriction at its proximal end. Besides this sub-terminal constriction, each of these large chromosomes exhibits secondary constrictions on its length. At anaphase, these constrictions are very clearly seen. Some of the chromosomes of the anaphase stage show a longitudinal split. In the telophase, the chromosomes fuse and form a deeply stained compact mass. The equatorial cell plate now completely divides the whole cell into two daughter cells.

The reconstructed daughter nuclei show one to three nucleoli. The nuclear reticulum is distributed at the periphery in contact with the nuclear membrane. The nucleolus is vacuolated and often shows crystalline bodies. Gradually a regular spireme appears with a distinct split here and there. The spireme then breaks up into broad thick bands which ultimately contract and form the chromosomes.

66. Studies in the cytology of the Liliaceae. II. Chromosome shape and number in *Gloriosa superba* L.

R. N. SUTARIA, Ahmedabad.

The writer has been engaged for some time in a study of the organization and behaviour of the chromatin material in the nuclei of the Liliaceae, and the present paper is a report upon the results of observations on the shape and number of chromosomes in the first (heterotypic) maturation division of *Gloriosa superba* L.

As the first maturation division prophase advances, a diakinesis stage is produced which is of striking appearance. The nuclear membrane disappears soon and the chromosome elements condense somewhat further. A multipolar spindle is soon replaced by a bipolar one, and the pairs of chromosomes are arranged at the equator. A polar view at metaphase shows eleven bivalent chromosomes. The chromosomes are unequal in size and more or less rounded or oval in shape. There are four different kinds of chromosomes. One of the bivalents is very big and rod-shaped, the two somewhat smaller than the single big one, the other four are still smaller and the rest of the chromosomes are the smallest. So far as the writer is aware, eleven as the number of chromosomes has not been recorded up till now in the Liliaceae. The homologues separate and pass to the poles. Soon after they reach the poles, they lose their rounded appearance and become V-shaped and some of them are constricted in the middle.

67. A study of some species and types of *Phleum*, *Phalaris* and *Festuca* with regard to chromosome numbers and breeding properties.

B. L. SETHI, Lahore.

Several types of *Phleum*, *Phalaris* and *Festuca* were studied from the cytological and breeding standpoints. This was expected to throw some light upon their proper taxonomic position, inter-breeding affinities and eventually upon the bearing of cytological investigations on the breeding results.

The chromosome complement of each plant was determined in root-tips and pollen-mother-cells. Seven was the basic number of chromosomes in each genus.

The artificially produced hybrid plant (*Phalaris arundinacea* L. x *Phalaris bulbosa* L.) showed irregularities in meiosis; in heterotypic metaphase 12 bivalent and 4 univalent chromosomes were observed, instead of 14 bivalent chromosomes as found in either parent. The univalents invariably lagged and followed a random distribution and generally remained as separate nuclei at each pole. This irregular behaviour produced binucleate, trinucleate and degenerate form of pollen grains.

It was noticed that six out of seven different strains of *F. rubra* were hexaploid forms. It is therefore evident that the hexaploid form has a particularly wide distribution and since chance collection gave plants of this type, it is probable that this type is also abundantly represented over this wide area.

Hybridisation was exclusively brought about by hand emasculation methods. The process in *Phleum* types was facilitated by emasculating the florets with the help of a magnifying glass and thinning out the inflorescence in such a way so that all but the florets in the two opposite rows are removed. On the whole, plants with lower chromosome numbers gave better 'takes' when used as female parent.

The cytological examination and breeding studies distinguished two groups of *Phleum*—the diploids and the hexaploids; readily crossable within the group but gave exceedingly low or no results in the inter-group crosses.

Reviewing the results as a whole, it becomes evident that inter-crossability (compatibility) in plants of the same genus depends upon two different things. On the one hand, extreme or pronounced differences in chromosome numbers at once makes inter-breeding a difficult matter. Thus in the genus *Phleum*, while different morphological types inter-breed quite readily provided they possess the same number of chromosomes the diploid and hexaploid types can only be inter-crossed with great difficulty. Exactly similar results were obtained in *Festuca ovina* and various morphological types of *F. rubra*. Types of similar chromosome numbers inter-crossed quite readily, but very poor results were obtained when attempts were made to inter-cross *F. ovina* (tetraploid) and *F. rubra* (hexaploid). On the other hand the two *F. rubra* types, hexaploid and octoploid, inter-crossed quite readily in both directions, so that it would appear that even where the chromosome numbers are different, if the difference is not very great, initial inter-crossing at least is readily possible.

In the *Phalaris* species studied, an entirely different position is found. Here the two species studied have the same chromosome number and yet they are not easily inter-crossable, while the hybrid produced bears only a very small proportion of good pollen grains. A study of this hybrid has shown that although the chromosome numbers in the two parents are the same, the chromosomes themselves are not identical since in reduction division faulty pairing occurs, which results in the formation of imperfect pollen grains. It is thus evident that while

chromosome number differences are extremely important, and prove to be a great obstacle to promiscuous inter-breeding, the same position may be reached along another line, namely, differences in the constitution of the chromosomes themselves.

68. Polyploidy in *Solanum melongena* L.

E. K. JANAKIMMAL, Madras.

A single giant plant of *Solanum melongena*, observed in a culture of 100 F_1 plants of a cross between a dark purple and a green fruited variety, showed 36 chromosomes in its root tips. The somatic number of chromosomes in *Solanum melongena* being 24, the plant is a triploid.

Binucleate pollen grains were observed in one of the parents, thus proving that triploidy might have arisen by the chance fertilization of a normal x gamete by one with a 2x number of chromosomes.

A comparative study of meiosis in the diploid and triploid is given. 14 seedling plants from a selfed fruit of the triploid showed 44–48 chromosomes in their root tips. Since there is random distribution of chromosomes during the reduction division in the triploid, tetraploidy in the progeny of the triploid must have arisen by the fertilization of gametes with the 2x or closely 2x number of chromosomes.

69. Chromosome stability in the genus Solanum.

P. BHADURI, Calcutta.

Chromosome counts of the Indian species of Solanum showed that twelve is the basic number in this genus. The chromosome number of the following plants have been determined for the first time : *S. trilobatum*, *S. indicum*, *S. torvum* and *S. verbascifolium*. The chromosome numbers of the following plants which have been already worked out by workers abroad have been re-confirmed from plants grown here : *S. xanthocarpum*, *S. melongena*, *S. lycopersicum*, *S. micranthum*. The haploid number of the above mentioned plants is twelve (12).

In *Solanum nigrum* L, the haploid chromosome number, which was reckoned to be 36 by the European investigators gave the following chromosome counts, viz., n 12; n 24; n 36.

There was not much variation in the pollen size in the diploid types of Solanum species investigated.

70. Mitosis in three species of Ficus, i.e., *F. religiosa*, *F. bengalensis*, and *F. krishna*.

S. L. GHOSE *and* L. S. BATH, Lahore.

The nucleolus in some cases has a vacuole. The approach of the prophase is indicated by the appearance of the reticulum. The chromosomes are formed from the reticulum in the manner described by Gregoire and Wyngaerts, as mentioned in Sharp's Introduction to Cytology, 1921, p. 152. The longitudinal split in the chromosomes during prophase was, however, not observed. Chromosomes at metaphase are thicker than those at prophase. The number of chromosomes in *F. religiosa*, *F. bengalensis* and *F. krishna* are 24, 20 and probably 16 respectively.

71. Microsporogenesis in *Dodonaea viscosa*.

S. L. GHOSE *and* L. S. BATH, Lahore.

The nucleoli of the spore-mother cells are pretty large. The major part of the staining material is lodged within the nucleolus. The spireme is formed telosynaptically and is connected with the nucleolus. This

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connection is visible even at the open spireme stage. A few anaphases of the heterotypic division, but none of the homoetypic one, were observed. During telophase fresh nucleoli arise in the daughter-nuclei as pale bodies which later on stain deeply. Cytokinesis takes place by furrows. The haploid and diploid numbers of chromosomes are 14 and 28 respectively.

72. The embryo-sac of Vanilla and the 'nucellar feeding tissue'.

M. A. Sampatkumaran *and* K. N. Seshagiriah, Bangalore.

The nucellus consists of a central row of a few prominent cells surrounded by a layer of epidermal cells The terminal cell of this central row is the archesporial cell, the remaining cells form a conspicuous 'nucellar feeding tissue' during the development of the embryo-sac and becomes even more conspicuous after fertilization.

The course of megasporogenesis is not always normal. Abnormalities occur. An eight nucleate embryo-sac develops from the chalazal megaspore.

Soon after fertilization, glandular cells from the inner wall of the carpel develop Simultaneously with the development of these secretory cells the 'nucellar feeding tissue' also becomes very conspicuous, degenerating only when the embryo is far advanced in its development. The existence of such a 'nucellar feeding tissue' has not been recorded as far as the authors are aware in the ovules of orchids

73. The development of embryo-sac and fertilisation in Jute.

I. Banerji, Calcutta

The development of embryo sac has been studied in *Corchorus capsularis* L, and also in *Corchorus olitorius* L

The archesporial cell is hypodermal in origin In some cases two archesporial cells have been found to occur side by side The archesporial cell functions as a megaspore mother cell and produces a normal linear tetrad of four megaspores. The first three megaspores from the micropylar end always degenerate, while the fourth develops and produces an octonucleate embryo sac No tapetal tissue has been observed. In the mature embryo-sac the synergids have pointed ends and conspicuous vacuoles placed distally. The egg is placed centrally between the synergids. The polar nuclei lie in the centre of the embryo sac and close to each other but do not fuse. The antipodals appear as separate cells with cytoplasmic walls. They degenerate very soon.

The pollen grains germinate on the stigma within thirty minutes after pollination and they traverse the stylar tissue in the course of next three hours. Pollen tubes have been noted in the micropylar end of the ovule six hours after pollination Generally one of the synergids disintegrates at this stage. The process of fertilization appears to be normal. Triple fusion of nuclei has been observed in a number of preparations. The process, however, appears to be slow The metaphase of the first division of the endosperm nucleus was first noted 72 hours after pollination.

74. The development of embryo-sac of *Cassia Tora* Linn.

R. M. Datta, Calcutta.

The archesporial cell is hypodermal in origin.

A normal linear tetrad is formed of which the first three cells disintegrate and the last functions as the megaspore.

The megaspore divides in the usual manner and produces an octo-nucleate embryo-sac.

The anti-podals are ephemeral in nature and become disorganised before the differentiation of the egg-apparatus.

The fully differentiated embryo-sac contains the egg cell, the two synergids, and the two polar nuclei.

The polar nuclei lie close together but do not fuse completely.

75. The development of ovule and embryo-sac in *Solanum melongena* L.

P. N. Bhaduri, Calcutta.

The ovule initials differentiate as groups of cells from the diffentiated sub-epidermal layer.

The single integument develops after the differentiation of the archesporium and when fully developed almost covers the deeply seated mature embryo-sac.

The megaspore mother cell originates in the hypodermis and is covered by a single layer of nucellar tissue. Sometimes two or three megaspore mother cells develop, either side by side or one below the other.

By two divisions, the megaspore mother cell gives rise to a linear tetrad of 4 megaspores. The chalazal megaspore develops and forms a normal eight nucleate embryo-sac, while the other three degenerate

The antipodals which appear to be lens-shaped cells degenerate before fertilization.

The embryo-sac is 'jacketted by a single layer of binucleate tapetal cells.

During the meiotic prophase of the megaspore mother cell alveolization and parallelism of the linen thread is quite conspicuous. Very tight contraction of the thread was not observed during synizesis The spireme comes out of synapsis in loops and is continuous. The longitudinal fission in the univalent spireme is homologous with that found in the early prophase, univalent chromosomes remain attached end to end forming the loops. The pairing of the univalent chromosomes begins earlier and is completed during the second contraction. The bivalent chromosomes begin to split apart as it comes out of second contraction. Heterotype chromosomes are formed by the segmentation and condensation of these univalent pairs attached end to end. The twelve bivalent chromosomes remain attached to each other by stainable material which appear as bonds between univalent chromosomes during early anaphase.

Homotypic split in the univalent chromosomes reappear suddenly during the anaphase of the heterotypic division

Chromatic protrusion from the nucleolus takes place from the early prophase to late diakinesis in the nuclei of the megaspore mother cell.

Alveolization and parallelism of threads is also present in the nuclei undergoing mitotic division in the embryo-sac.

The twelve haploid chromosomes found in the mitotic division in the embryo-sac are curved like the somatic chromosomes of the sporophyte.

76. Cytology of Capsicum.

A. R. Banerji, Calcutta

The ovule initials originate from the sub-epidermal layer of the placental tissue.

The nucellus consists of a very small number of cells.

There is a single and massive integument which covers the nucellar tissue, the innermost layer of which serves as the tapetal layer.

With the growth of the integument the ovule bends and becomes anatropous.

Always a single megaspore mother cell differentiates which does not cut any parietal cell and by two successive divisions gives rise to 4 megaspores arranged lineally.

Three megaspores degenerate, the innermost or chalazal one functions and produces the female gametophyte.

Normal method of embryo-sac development is observed with 2 beak-shaped synergids, one egg, 2 polars and 3 antipodals. The antipodals soon degenerate.

The floral organs appear in accropetal succession, and after their differentiation, the primordia from which the stamens and corolla had originated grow *en masse*, and thus bring about the epipetalous nature of the stamens in the mature flower.

In meiosis of the pollen mother cells the archesporium originates in the hypodermal layer.

There is marked differentiation of tapetal tissue which becomes bi-nucleate by a single mitotic division.

Periplasmodium formation was observed by the dissolution of the tapetal cell-wall and the fusion of the protoplasm.

Meiosis has been studied both during micro- and megasporo-genesis. The spireme shows alveolisation throughout. The manner of pairing of the synaptic mates has been shown to be in accordance with the telosynaptic theory.

Multipolar origin of the spindle has been recorded.

Two types of fibres are distinguished in the spindle.

Cytokinesis takes place by vacuolation.

Tetrad chromosomes were observed in megasporogenesis.

The nucleolus shows nucleolar protrusion and distinct reduction in size with the onset of the metaphase.

Chromosome numbers in *Capsicum annuum* and *C. frutescens* have been determined and were found to be 12 haploid. In *C. annuum* the counts of previous investigators have been confirmed. The chromosome number for *C. frutescens* has been determined for the first time.

77. The development of the flower in Jute.

I. Banerji, Calcutta.

The development of floral organs has been studied in *Corchorus capsularis* and *Chorchorus olitorius*. The flower primordium appears first as protuberance in the axil of a bract. The sequence of development of the flower appears to be sepals, petals, stamens and pistil. The calyx has very pronounced growth and completely encloses the flower from a very early stage. The growth of the petals is arrested at an early stage. The petals, however, resume growth and become differentiated when the other floral organs have been developed and when pollen formation is nearly complete in the anthers.

78. Contributions to the life history of *Eclipta erecta.*

H. R. Bhargava, Agra.

Eclipta erecta is a common Composite here. The central flowers are all tubular and hermaphrodite, while the ray-flowers are female with no trace of the stamens.

The anther wall consists of three layers below the epidermis, endothecium, one middle layer and the tapetum. The tapetum is two to many nucleate. The nuclear divisions are mitotic and there is a frequent fusion of the nuclei in each cell. The microspores are arranged tetrahedrally. The mature pollen-grain has a crescent shaped generative cell and a tube nucleus.

A hypodermal cell of the young nucellus forms the primary archesporial cell. This cell functions directly as the megaspore mother cell

which enlarges rapidly and divides to form a linear tetrad of four megaspores. The lowest megaspore functions, the other three degenerate. There is a single massive integument and the ovule quickly becomes anatropous. The nucellus is very thin.

The mature embryo-sac is long and narrow and of the eight nucleate type. At the micropyler end there are the two long synergids with slightly developed hooks and the egg, and at the other extremity are the three antipodals. The two polar nuclei meet in the centre to form a fusion nucleus. The mature embryo-sac is surrounded by a nutritive jacket of densely staining cells. Pollen tubes were present in the older ovules, which is indicative of normal fertilization.

79. Abnormal plants of *Argemone mexicana.*

A. C. Joshi, Benares.

Two plants of *Argemone mexicana* were found at Hoshiarpur (Punjab) differing in several respects from the normal. The calyx was persistent even in the fruit, not caducous as is the case usually. Corolla was mostly green. In some flowers it showed several shades between green and yellow. It was persistent even in the fruit like the calyx. Most of the stamens appeared to be sterile. The ovary had a small stalk and was crowned with a distinct style. In most cases it curved outwards. The leaves were quite normal. Both of the plants were quite healthy and showed no signs of an attack either by any fungus or insect. The exact cause of these abnormalities is not known but the sterility of most of the stamens suggests some sort of crossing to have caused these variations.

80. Secondary thickening in the roots of *Stelleria chamae-jasmae.*

A. C. Joshi, Benares.

The roots of *Stelleria chamae-jasmae* possess a unique type of secondary thickening, something like which has been described only in the roots of a species of Myrrhis. The primary structure of these roots is quite normal except that it has not been possible to make out the number of protoxylem groups. The primary cambium originates quite in the normal way but soon after another cambium is formed on its inside probably from the wood parenchyma cells or from the pre-existing cambium itself and begins to function in a way quite opposite to that of the primary outer cambium. The primary cambium forms wood on the inside and phloem centrifugally, but the inner secondary cambium forms wood on the outside and soft bast centripetally. The outer cambium is fairly regular in outline, but the inner one is very irregular, bulging inwards and outwards at a number of places. The outer cambium also bulges inwards at some places, where the inner one is bulging outwards. The two then meet and break up the stele into several parts. Many other small separate steles are formed by the looping of the inner cambium alone. All these go on increasing independently in size and the result is the formation of a very complex type of polystele. The shoot of this plant shows normal structure.

81. The perennation method of *Zeuxine sulcata.*

A. C. Joshi, Benares.

The perennation method of *Zeuxine sulcata*, the little orchid found all over Northern India, is of a very simple but not of a very common type. Towards the end of the growing season, at the base of the flowering axis, under the earth, certain shoots are formed. These remain underground

during the first year and all the available food passes into these shoots and is stored there. After flowering and fruiting, the main shoot dies away, but these branches are left behind. In many cases these have developed their own roots before the death of the main shoot. On the coming of the next favourable season, these underground shoots grow up into new plants. As generally more than one underground shoots are given off from one plant, this method serves in vegetative propagation also. Among the tuber-forming species, this mode of perennation has a close resemblance with that of the Ophrydineae, where the tuber represents next year's stem-bed, fused with the fleshy adventitious root standing exactly beneath it and it is suggested that this method has originated from the less complex Zeuxine condition.

82. Microstructure of the shoot of *Dioscorea alata* Linn. With reference to its specific distinction.

EKENDRANATH GHOSH, Calcutta.

Microstructure agrees in general with that of other species, both of the same genus and of the other genera. Stem, with depressed, capitate hairs, scanty collenchyma, endodermis of one layer of small cells and with thick 6-celled layer of sclerenchymatous pericycle. Vascular bundles 13 in number and arranged in a ring; they consist of 4 large (beneath the furrows) 3 medium-sized (beneath the 3 wings) and 6 small bundles between them. Xylem vessels in two radial rows, right and left, converging both externally and internally and connected by small vessels at their ends. Xylem vessels divisible into an inner, middle and outer groups, middle one consisting of large vessels. Phloem in small patches, 2-3 in number. Their position is characteristic of the species. Sclerenchyma well-developed in the bundles surrounding the phloem. Petiole with feeble collenchyma, an irregular row of cells representing the pericycle and 7 bundles, 5 large beneath the 5 wings and 8 small beneath the upper surface. Lamina with upper epidermis of one layer of large cells. Palisade parenchyma of one layer.

The thick sclerenchymatous pericycle, circularly-placed vascular bundles with peculiar arrangement of the vessels and that of the phloem in one or more patches are characteristic of the family, Dioscoreaceae. The number, variety and disposition of the bundles and the position of the phloem are of specific value.

83. Studies in the morphology of pollen grain—III (*a*) Cucurbitaceae.

T. C. N. SINGH, Benares.

A study has been made of the pollen grain of the species belonging to the following eleven representative genera :—*Trichosanthes*, *Luffa*, *Momordica*, *Cucumis*, *Citrullus*, *Coccinia*, *Cucurbita*, *Melothria*, *Bryonopsis*, *Lagenaria* and *Benincasa*.

The structure including external shape and form of the pollen grain both under dry and wet conditions is described. It is striking that in most the pollen grains appear to have germinated *in situ*, some of them being possessed of rather long pollen-tubes.

The results obtained are discussed in the light of systematic relationship of the species under study.

84. On the production of secondary root-hairs on old root-stocks of Cambodia (*Gossypium hirsutum*).

T. C. N. SINGH, Benares.

Cambodia is one of the important cottons which has been engaging the attention of investigators on account of the physiological disease (Red

leaf blight) from which it suffers so very considerably. It is interesting to note that root-washings of these plants have shown a peculiar phenomenon in the fact that root-hairs have been found (formed secondarily) on old-root-stocks in quite a great abundance in addition to those which occur normally a little behind the root-tips. The root-hairs thus formed, like the normal root-hairs, are elongate and uni-cellular with one nucleus each.

The significance of this important physiological phenomenon is discussed in the fuller paper.

85. Extra-floral nectaries in *Ricinus communis* and their role in pollination.

N. M. Mukerjee, Agra.

Such nectaries are observed to occur in the castor plant in place of stipules and on the petiole and at joint of the petiole with the lamina. They occur on all the leaves since the early stage of the plant although in a rudimentary condition specially the stipular ones. Their secretion attracts insects like ants which may be observed visiting these nectaries. But when the inflorescence appears with its female flowers at the top and the male ones at the lower end of the axis the importance of the nectaries can be understood. The inflorescence is surrounded on all sides by leaves with their petioles obliquely pointing upwards. The disposition of the nectaries on inner side of the petiole facing the inflorescence and along the length of petiole seems to suggest this to be a device for attracting the insects to the lower region of the male flowers, thus securing self or cross pollination.

86. Seedling leaves of Leguminoseae.

N. M. Mukerjee, Agra.

An interesting feature observed in the behaviour of the first leaf after the cotyledon in the three sub-families of Leguminoseae. Observations made on seedlings of a number of species of the three sub-families so far observed showed that the first leaf of the Papilionateae is always simple even in cases where the adult left is compound, the subsequent leaf assuming the normal form. In the cases of Caesalpinoideae and the Mimosoideae however the first leaf after the cotyledons is compound (or lobed in Bauhinias) the subsequent leaves assuming normal form. This fact may have some bearing on the evolutionary history of the three sub-families of the Leguminoseae.

87. A note on the germination of seeds of *Nelumbium speciosum*.

N. M. Mukerjee, Agra.

The 'seed' is really a nut with a hard pericarp containing inside a well developed embryo with two distinct green leaves in the plumle. Radicle is functionless and the cotyledons are retained inside the nut. The nuts first float in water to secure dispersal, then finally sink for germination. The first leaf emerges out of the crack at the lower end of the nut by pushing out the petiole in the form of a loop and the blade is then gently drawn out. The petiole of the first leaf lengthens out and then emerges the second leaf in the same manner, the stem also appearing at the same time. Adventitious roots appear on all sides round the stem at the place of its emergence from the nut. By the time however the first leaf assumes the floating position, the nut hangs down like an anchor, and the roots therefore develop more on the lower side. The continuous

growth of the embryo is remarkable and may be considered as a case of vivipary. The retention of the germinating plant in the fruit appears also to be biological adaptation as found in other aquatics like Trapa.

88. Two and three carpels in *Cassia fistula* flowers.

A. SAWHNEY, Amritsar.

The family Leguminoseae is characterised by a single carpel but some flowers of *Cassia fistula* have been observed in which the number of carpels is two or three. When the carpels are two in number they are found lying side by side with the basal part of the gynophores fused together while a part of the gynophores and the ovary, etc., remain free from one another. If the number of carpels is three, one of the carpels is fused by its gynophore to the fused basal portions of the gynophores of the other two carpels only for some distance. The gynophores of the other two carpels separate at a little higher level. All the three gynophores, however, can be traced to the base and the three carpels lie side by side.

89. Tri- and tetra-carpellary, siliquas of *Eruca sativa.*

A. SAWHNEY, Amritsar.

Siliqua is a characteristic fruit of the family Cruciferae. It is developed from the ovary of a bicarpellary pistil, in which there are two parietal placentas and a false septum stretching between them. In *Eruca sativa* this false septum is continued as a flat beak at the top of the fruit. Interesting cases, however, have been observed where the number of carpels is three or four. The third carpel always arises at a higher level than the normal two and is alternating with them. The fourth carpel arises opposite the third one (alternating with the normal two) at the same level or again a little higher up. The beak in those cases is tri- or tetra-gonous accordingly as the number of carpels forming the fruit is three or four. The fruit is three chambered in both the cases. When the carpels are three the septa separating the chambers are radially arranged but if the number of carpels is four the three chambers are arranged in a row transversally.

90. Morphology of Balanophora.

M. A. SAMPATKUMARAN *and* L. N. RAO, Bangalore.

PALAEOBOTANY.

91. On a specimen of *Zygopteris primaria* Cotta showing the stem and leaf-trace sequence, with remarks on the mode of emission of the pinna-traces.

B. SAHNI, Lucknow.

Just over a century ago Bernhard Cotta described, from the Permian of Saxony, a silicified zygopterid fern under the name *Tubicaulis primarius.* Only one specimen of this important species has yet been described, and in the several fragments of it, now in the museums at Freiberg, Chemnitz, Dresden, Berlin, London, and Paris, all of which the present author has recently examined, there is no trace of the stem; our knowledge is confined to the petiole and that too is inadequate.

The author now describes the root, stem and leaf-trace sequence from an old specimen in the Cotta Collection at Berlin, which had been overlooked for many years. He is indebted to Dr. Julius Schuster of the Museum für Naturkunde of the Berlin University for drawing his attention to this fossil and for permission to describe it.

The stem has a large protostele with an enormous development of secondary wood, as in *Botrychioxylon paradoxum*. The root is usually diarch and also shows a great development of secondary xylem. As seen in serial sections from below upwards the leaf-trace is at first an elliptic bipolar strand with usually some secondary xylem over the two ends and sometimes all round the bundle. At this stage the strand often shows a slight curvature with the concavity outwards, that is, away from the stem stele. Higher up, the secondary wood is lost, and the bundle straightens out into a tangentially extended band, from the two ends of which perpendicular processes are thrown out. The bundle thus acquires the appearance of an H with an usually long horizontal bar, thus H. Careful investigation of the mode of origin of the pinna-traces in both the specimens has shown that the previously published accounts (Stenzel 1889, P. Bertrand 1909) are incorrect in important points. It has been found that the structure and mode of branching of the petiolar bundle is in every essential respect identical with that of the genus *Etapteris* of Bertrand (1907).

We may thus say that *Zygopteris primaria* was a fern with the stelar structure of *Botrychioxylon* (Scott 1912) and the petiolar structure of *Etapteris* (Bertrand 1907). Had the details of the petiolar structure and the mode of omission of the pinna-traces in *Z. primaria* been correctly elucidated by Stenzel and Bertrand, the form genus *Etapteris* would not have been founded. The question now is, whether *Etapteris* should still be maintained for the detached petioles or whether it should be merged in the much older genus *Zygopteris* of Corda (1845).

92. *Dadoxylon Zalesskyi*, a new species of Cordaitean trees from the Lower Gondwanas of India.

B. Sahni, Lucknow.

Under this name it is proposed to describe a silicified stem from near Asansol, in the Raniganj Coalfield, Bihar. The fossil was kindly sent to the author by Professor K. K. Mathur of Benares Hindu University, to whom his sincere thanks are due.

Silicified wood of the *Dadoxylon* type has long been known to occur in the Raniganj area, and in recent years large tree-trunks have been discovered near Asansol on the E. I. Railway (*Rec. Geol. Surv. India*, vol. 58, pp. 75–79). The Geological Survey of India have reason to believe that this fossil wood occurs at a definite horizon in the Raniganj Series (C. S. Fox, 1928, *Rec. Geol. Surv. Ind.*, vol. 60, pt. 4). The presumption is that all these trees were Cordaitean (not Araucarian), and most, if not all, of them may have belonged to one species. But owing to poor preservation and especially owing to the fact that the pith and primary wood have not been found preserved in any of them, it has not so far been possible to determine their affinities.

The interest of the present specimen lies in the fact that the pith and primary xylem are preserved both in the main axis and in several lateral branches. The structure shows that the stem belonged to a Cordaitalean tree of the Gondwana type. The close resemblance both in external characters and in the structure of the secondary wood with the large trees from Asansol supports the view that the latter also belong to *D. Zalesskyi*, but this cannot be proved unless the pith and primary structure is shown to be the same.

The pith is large and cylindrical (not discoid as in the northern Cordaiteae). The protoxylem is simple, not showing any parenchyma islands such as Miss Holden described in D. *indicum* (*Ann. of Bot.*, vol. 31, pp. 315–320). From *D. bengalense* (*Ann. of Bot.*, vol. 31, pp. 320–324) the new species differs in the absence of any *Callixylon*-like grouping of the radial pits on the secondary tracheids and in other respects.

D. Zalesskyi is thus distinct from both the previously described Indian species, which are said to be of Barakar (= Lower Permian) age. If, as is most probable, the present specimen comes from the same geological

horizon as the numerous other specimens found in the Raniganj area, its age would be distinctly younger, for it would correspond to the Raniganj Stage, which is generally regarded as late Permian.

93. *Palmoxylon Mathuri*, a new species of petrified palms from Cutch, Western India.

B. Sahni, Lucknow.

A silicified block from Laknipur in Cutch kindly sent to the author for investigation by Professor K. K. Mathur of the Geological Department, Benares Hindu University, is here described under the name *P. Mathuri* sp. nov.

The preservation is excellent. In the ground-tissue scattered round fibrous bundles are present. The parenchyma is interesting on account of its markedly lacunar character, the individual cells as seen in cross-sections of the stem being narrow and much elongated in the horizontal direction, with very large interspaces.

Geological age, unknown.

94. Anatomical proof of the Cycadophyte affinities of *Taeniopteris spatulata* McCl.

B. Sahni, Lucknow.

Some silicified blocks from the Rajmahal Hills (Santal Parganas, Bihar) are largely composed of petrified leaves of *Taeniopteris spatulata* McCl. This is a characteristic Jurassic fossil with a wide geographical distribution, which has hitherto been found only as impressions, and of which the affinities are therefore uncertain.

Thin transverse sections of the leaf show, in the rather broad mid-rib, a row of mesarch collateral bundles of typical cycadean structure. There is a well developed triangular patch of centripetal xylem; the centrifugal xylem is separated by thin-walled tissue from the protoxylem; there is marked evidence of secondary growth in the abaxially placed phloem. Longitudinal sections of the lamina, cut parallel to the midrib, show a horizontal series of bundles (the lateral veins) each placed in the middle of a girder of mechanical tissue.

The general belief that *T. spatulata* was the leaf of a fossil cycad and not of a fern is strengthened by the analogy of *T. vittata*, an allied species of frond which most probably belonged to *Williamsoniella coronata*. The present work provides the first anatomical evidence in support of this view.

The material was found by Mr. G. V. Hobson of Geological Survey of India, and is being described with the kind permission of the Director.

95. *Conites Hobsoni*, a new species of fossil ovuliferous cones from the Rajmahal Series, Bihar.

B. Sahni, Lucknow.

The silicified leaves of *Taeniopteris spatulata* described in the above paper are associated with numerous vegetative shoots of *Brachyphyllum* and some small silicified ovuliferous cones here described as *Conites Hobsoni* sp. nov.

There is some evidence, although definite proof is still lacking, that these cones were borne upon the associated *Brachyphyllum* shoots, which externally resemble *B. mamillare*.

So far as it is known at present the cone-scales were simple; a single ovule was placed on the adaxial side of each scale. The anatomy of the cones is described in detail.

It has been suggested by others that at least some species of *Brachyphyllum* were conifers of araucarian affinity. This suggestion would find strong support if the attribution of *Conites Hobsoni* to the associated shoots is confirmed.

The author is indebted to Mr. Hobson and to the Director of the Geological Survey for the loan of the material for investigation.

96. On a collection of fossil plants from the Rajmahal Hills, Bihar.

B. Sahni *and* A. R. Rao, Lucknow.

In December, 1927, a party from the Botanical Department of the Lucknow University visited several localities in the northern part of the Rajmahal Hills, Bihar, where plant-bearing beds of Jurassic age, interstratified with volcanic lavas, are exposed in numerous patches. The chief localities where fossil plants were collected are near Mirzachowki, near Sakrigali Ghat and Onthea. The following is a provisional list of the species collected :—

EQUISETALES.—

Equisetites sp.

FILICALES.—

Sphenopteris Hislopi O. and M.
Sphenopteris sp.
cf. *Coniopteris hymenophylloides* Brongn.
Marattiopsis macrocarpa Morris sp. (including fertile leaves).
Gleichenites gleichenoides.
Cladophlebis indica O. and M. sp. (also a fertile specimen).
Rhizomopteris sp.

CYCADOPHYTA.—

Ptilophyllum cf. *P. cutchense* Morris.
P. acutifolium O. and M. sp.
Otozamites parallelus Fst. sp.
Zamites proximus Fst.
*Pterophyllum incisum sp. nov.
Pterophyllum sp. α.
Pterophyllum sp. β.
Dictyozamites falcata Morris sp.
D. indica Fst. sp.
*D. Hallei sp. nov.
Taeniopteris spatulata McCl. sp.
T. McClellandi O. and M. sp.
T. (? *Nilssonia*) spp.
Nilssonia (? *Anomozamites*) *fissa* Fst. sp.
N. Morrisiana O. and M. sp.
N. princeps.
Seeds, probably of *Nilssonia* sp.

CONIFERALES.—

*Araucarites Florini sp. nov. (megastrobili).
Araucarites sp.
Elatocladus conferta O. and M. sp.
E. tenerrima Fst. sp.
E. spp.
Brachyphyllum expansum Sternb. sp.

INCERTAE.—

Podozamites sp.
cf. *Cycadolepis.*
Indeterminable fragments, including silicified wood.

The three species marked * are new.

PHYSIOLOGY AND ECOLOGY.

97. Part played by living cells in the ascent of sap.

T. EKAMBARAM *and* I. MADHUSUDANA RAO, Madras.

Experiments were conducted to find out the part played by living cells in the ascent of sap.

Shoots of *Barleria cristata* were selected for the work as many others were unsatisfactory.

Special apparatus was devised for recording automatically the rate of absorption and rate of transpiration under different treatments. The quantities recorded were ·03 c.c. to ·05 c.c. of water in absorption and 20 milligrammes in the course of evaporation.

When water was supplied at the cut end, rate of absorption and transpiration was found to be almost constant till 3 p.m. when there was a slow fall.

When 20 per cent. Formalin solution was supplied at the cut end, the rate of absorption was almost constant for about an hour, when there was a visible fall in the rate. This reached a maximum of about one-third the rate in water and by this time all the leaves were discoloured generally. The rate recovered to some extent afterwards.

Rate of transpiration was affected slightly with the same treatment after half-an-hour; the rate was reduced to half the rate in water but the recovered rate was usually either equal to the rate in water or even quicker.

When the leaves were coated with pure Formalin, the fall in the rate of absorption started in 15 minutes, the rate becoming one-third the normal or even less in half-an-hour to one hour, and recovered equally rapidly to a varying extent rarely approaching the rate in water.

The rate of evaporation was not reduced with this treatment. It was even quicker after the leaves were discoloured.

The leaves were coated with pure Formalin. When the rate, after recovery from the fall, was more or less constant, 20 per cent. Formalin was added at the cut end. There was no fall in the rate after the second treatment. The graph followed the course of the one obtained in Section 3.

It is inferred from these experiments that the fall in the rate of absorption is due to changes brought about in leaf cells by the poison and that the cortical cells of the stem take no part in the ascent of sap.

The factors involved in bringing about changes in the absorption and transpiration curves under Formalin treatment are discussed.

Porometer readings were taken when 20 per cent. Formalin was added at the cut end and were compared with those of control plants. The stomata were open when the leaves were killed (after discolouration).

98. On the effect of long and short-day illumination on the growth of tropical plants—II.

B. N. SINHA, Chapra.

Experiments on the effect of different periods (control in shade; experimental under the following hours of exposure 7 a.m. to 9 a.m.; 7 a.m. to 11 a.m.; 7 a.m. to 1 p.m.; 7 a.m. to 3 p.m.; 7 a.m. to 5 p.m.) of direct

exposure to sunlight have been made on the following three species of crop plants :

(*a*) *Brassica campestris* var. *Sarson.*
(*b*) *Cajanus indicus* Spreng.
(*c*) *Hordeum vulgare* L.

It is interesting to note that the results obtained are in conformity with my last year's experiments on gram (see *Proc. Indian Sc. Congress*, 1931). They are as follows :

Germination.—The germination was certainly quicker in the pots less exposed to the sun.

Aerial shoot.—With the increase of sun-illumination there was a decrease in the length of the aerial shoot but the laterals were much better developed and the leaves were darker green.

Root-system.—Just the reverse was the result obtained in the case of the root-system, namely that, the longer the plants exposed to the sun the longer was the root-system developed. A difference of nearly two times was noticed in the length of the root-system of the plants exposed to the sun throughout the day as compared to the control.

99. On the effect of Copper-sulphate on the growth of gram (*Cicer arietinum* L.)

B. N. Sinha, Chapra.

Series of experiments have been performed by the author with different strengths of Copper-sulphate solution on gram. The control plants were, however, treated with spring water. The treatments were continued throughout the life-history of the plants. The following results have been obtained :

Germination.—Practically no difference was noticed.

Aerial shoot.—Plants treated with weaker (1·5 per cent.) solutions displayed the best shoot development both with regard to length and lateral expansion. But with higher doses than 1·5 per cent., they showed unhealthy signs of growth.

Root-system.—As in the case of aerial shoot so also in this case weaker doses stimulated the growth in length and also lateral expansion of the roots, while higher doses definitely retarded growth.

Flower and Fruit.—The same dosings which were conducive to the better development of the shoots and roots, also stimulated early flowering and fruiting, the best results being obtained in plants treated with 1·5 per cent. solution.

100. Diurnal movements of the leaflets of Sesbenias.

N. M. Mukerjee, Agra.

The leaflets of the pinnate compound leaves of *S. gradiflora* and *S. aegyptiaca* were observed to constantly rotate and adjust themselves to fully face the direction of sunlight in course of the day. They were observed to face eastwards in the morning light, assumed the horizontal position at mid-day and faced westwards in the afternoons and the evenings, in darkness they returned to the sleeping position. Only on cloudy days they did not show this movement and remained in more or less the horizontal position.

101. Staminal movements in *Gerbera lanuginosa.*

B. Sahni, Lucknow.

The author records the occurrence of staminal movements in a common N.W. Himalayan plant, *Gerbera lanuginosa* (Compositae), which is widely distributed in the Punjab Hills at altitudes between 5,000 and 7,000 feet above sea-level.

The movements are remarkably like those well known to occur in *Centaurea*, and the mechanism is the same, namely, a shortening of the filaments owing to diminished turgidity of their cells. When the disc floret is ready to be stimulated the tip of the anther tube is closed by the five valves of the tube meeting in a point at the top. The staminal column presents exactly the same subulate, very slightly curved, appearance as in *Centaurea*. If the tip is gently tickled the staminal column becomes visibly shorter, at the same time swaying gently to one side or the other in the same manner as in *Centaurea*. The tip of the anther tube is then seen to be covered by a mass of pollen; if one observes the process carefully with a strong pocket lens, the fairly large pollen grains are seen forced out in strings through the five chinks between the valves of the anther tube.

There is a slight difference from *Centaurea* in the structure of the style. In *Centaurea* the style is covered by upwardly pointed hairs and at a point below the bifurcation of the stigmas there is a ring of specially long bristles, which aid in sweeping the pollen up through the anther tube. In *Gerbera* there is no such bottle-brush arrangement. The opposed stigma lobes are together slightly thicker than the style and serve merely as a piston to push the pollen forward. The lower parts of the filaments are of a yellow orange colour and under the microscope their surface appears papillate.

The author is not aware that these movements have previously been recorded in the genus *Gerbera*.

102. Variability of the osmotic strength of the sap of Cuscuta.

P. Parija *and* A. B. Saran, Cuttack.

(A) With a view to finding out the extent to which the osmotic strength of the sap of a plurivorous parasite like Cuscuta could vary, twigs of the host were supplied with various concentrations of grape-sugar thus raising the osmotic strength of the sap of the host. Consequent on this, the sap of the parasite rose in strength but up to a maximum. If the strength of the host-sap was raised further, the parasite-sap showed no further rise but the quantity of starch in the cells of the parasite increased. The range of variation was about 10 per cent. below the maximum.

The sap strength of all the available hosts (7 genera representing 5 families) falls within this range.

(B) Incidentally it was observed and investigated that only chemical stimuli induce the production of haustoria.

103. Dormancy of the seeds of the Water Hyacinth.

P. Parija *and* B. K. Kar, Cuttack.

The seeds of the water hyacinth remain dormant for at least one season, i.e., from November to June, and retain their viability for several years. An attempt was made to ascertain the cause. It is found that :—

(*a*) The embryo is fully developed when the capsule bursts and thus the under-development of the embryo cannot be the cause of dormancy.

(*b*) The seedcoat is the main cause of dormancy.

(*i*) by offering physical resistance, as the seeds could be made to germinate by rupturing the coat with a scalpel;

(*ii*) by preventing the entry of oxygen, as seeds could be made to germinate by bubbling oxygen through the water in which seeds were soaked.

(*c*) This confirms the suggestion put forward by one of the authors that the mud-covered seeds in the field do not germinate for lack of oxygen.

104. Study of the Latex. I. Daily variation of sugar in the latex of *Plumiera acutifolia* Linn.

P. PARIJA *and* B. K. KAR, Cuttack.

With a view to studying the effect of restricted supply, or absence, of oxygen on the composition of latex, preliminary study of the sugar variation in the latex of *Plumiera acutifolia* was undertaken. Calvert's method was used in estimating sugar. The results are set out in this paper and an attempt is made to correlate the variation in sugar with light and temperature.

105. The effect of light on the respiration of starving leaves. II. Estimation of sugar in starving leaves of Aralia before and after exposure to light.

P. PARIJA *and* A. B. SARAN, Cuttack.

It was reported last year that very short exposures (7·5 mins.) to light raised the rate of respiration of starved leaves. With a view to seeing whether light brings about any change in the sugar concentration, leaves were analysed for sugar both before and after exposure to light. Calvert's method used by Dastur was used for the analysis. It is found that short exposures (7·5 mins.) in some cases more than doubles the sugar contents which in the unexposed leaves is of the order of 0·002 grs. per 10 grs. fresh weight.

106. Daily variation of sugar in the leaves of tropical plants.

B. K. KAR, Cuttack.

Quantitative estimates of sugar by means of Pavy's solution were made from the leaves of the following plants :—

Monocots.	*Dicots.*
1. *Allium tuberosum.*	1. *Mangifera indica.*
2. *Eichhornia* sp.	2. *Gossypium neglectum.*
3. *Arundo donax.*	3. *Helianthus annuus.*

The estimates were made at every 3 hours interval and carried over to 24 hours. The following interesting facts were noted :—

Both monosaccharides and disaccharides increase rapidly in amount after daybreak reaching the maximum at about mid-day after which the quantities of each fall rapidly till the following dawn. In *Dictos* a secondary rise much lower than that of the day is seen at 1 a.m. This secondary rise is either absent or if present quite negligible in case of *Monocots.*

The variation of the total reducing sugars is generally similar in every case; but individual sugars show different variation in different plants.

In dark there is continuous fall in total sugar. In some cases the fall in monosaccharide values are more marked than in disaccharide values.

An important relation between disaccharide and monosaccharide values has been derived by taking the disaccharides as unity.

This ratio has been shown to have a constant and higher value during the day and a lower but constant value during night.

107. Analytic studies in respiration of apples in low concentrations of oxygen.

K. A. Rafique, Aligarh.

It is proved by the analysis of the CO_2-production of apples in moderately low oxygen concentrations into its anaerobic component—NR—and its aerobic component—OR—that on alteration of the oxygen content in the environment, the OR component falls steeply while the NR exhibits an initial hump which is immediately followed by a slope. It becomes evident from a consideration of the behaviour of the two components that the oxidative mechanism adapts itself to the altered supply of oxygen much more rapidly than the mechanism which is responsible for activation of the pre-glycolytic phase, in consequence of which a major portion of the products of glycolysis goes to NR. It is further shown how Glycolysis, NR, OR and its concomitant OA (oxidative anabolism) can be evaluated separately.

108. Water requirements of winter crops.

Murarilal, Lahore.

Water requirements of wheat, gram, oat and pea were found by the method described by Maximov. These were 952,1406, 774,1230 respectively in unmanured plants.

Effect of manure and soil moisture was studied. The addition of manure in grams decreased the transpiration ratio from 1406 to 1215. A low percentage (17 per cent.) of soil moisture in oats gave a low transpiration ratio (424) as compared to 774 with 23 per cent. soil moisture.

109. Bathymetrical survey of the Dal Lake of Kashmir with special reference to the penetration of actinic rays to different depths of water and their effect on the incidence of vegetation.

S. K. Mukerji, Lucknow.

A survey of the Dal Lake was made to find out its depth in different parts. Numerous charts were prepared showing depth and vegetation. During summer (June and July), the deepest parts of the Dal seldom exceed twenty feet, while those of Lake Manasbal 45–50 ft.

The measurement of light intensity (active rays) was made at different depths of the Dal during the growing season, i.e., summer of 1929. For this purpose, the author constructed a special apparatus which is a kind of photometer. The potassium iodide method was not employed deliberately, owing to its many inherent and serious defects as pointed out by Pearshall.

The percentage of illumination at different depths varies according to degree of sedimentation and density of vegetation. In clear and still water, the light intensity measured 33·3 per cent. at a depth of one foot, 15·2 per cent. at 2 feet, 8·9 per cent. at 3 feet and 1·2 per cent. at 15 feet. In Manasbal Lake, however, light intensity measured 8·2 per cent. at a depth of 16 feet, 38·2 per cent. at 5 feet, and 75 per cent. at a depth of one foot. The vegetation in the Dal Lake is found up to a depth of 17 feet whereas in the Manasbal Lake, of which the water is six to eight times clearer than in Dal (judged from the percentage of light penetrating different depths) the vegetation extends further down to a depth of about 25 feet. By vegetation the author means macroscopic vegetation and not microscopic. The plants that can grow to such great depths are *Chara fragilis*, *Nitella acuminata*, *N. dispersa*, *N. hyalina*, *Nitellopsis obtusa*, *Ceratophyllum demersum*, *Potamageton crispus*, *P. pectinatus*, *P. lucens*, and *Myriophyllum verticillatum*. These plants appear to possess great powers of tolerating very low intensities of light, although

they are fully capable of growing in very bright light. There are other plants such as *Nymphaea alba*, *Nelumbium speciosum*, *Euryah ferox*, *Potamogeton indicus* and other members of the floating leaf association which demand higher percentage of illumination at the time of the commencement of vegetative activity after winter lull.

The vegetation is practically non-existent or scanty in those parts of the Dal where plenty of sedimentation occurs. This is partly due to poor penetration of light.

In the Reed-swamp zone of Carex, Phragmites and Typha, the penetration of light is much poorer, owing to density of both benthos and free-floating vegetation.

110. On the genus *Artemisia*—its species, varieties and ecads as found in Kashmir.

S. K. MUKERJI, Lucknow.

The author has made a special study of the genus *Artemisia* and has collected as many as eighteen species from various localities and distant mountainous regions of Kashmir. When working at Kew Herbarium, he identified the following species:—*Artemisia salsoloides*, *A. dracunculus*, *A. glauca*, *A. parviflora*, *A. scoparia*, *A. maritima*, *A. brevifolia*, *A. Tourenefortiana*, *A. amygdalina*, *A. Roxburgiana*, *A. vestita*, *A. laciniata*, *A. Sikrorum*, *A. Moorcroftiana*, *A. Falconeri*, *A. absyntheum*, *A. sieursiana*, and *A. vulgaris*.

An ecological and taxonomic study of *Artemisia maritima* was made in the Gurez Valley and the Nanga Parbat Region of Kashmir in the summer of 1929. It was found that most of the hill sides were densely clothed with at least three varieties and ten habitat-forms of this species. Natural regeneration by seedlings takes place extensively. It appears that the seeds lie dormant only for a short time and they germinate during the same season. Further development of seedlings is arrested owing to heavy fall of snow, under which seedlings in different stages of growth remain buried throughout the winter.

The yield of santonine from this plant is found to vary with the climatic conditions prevailing at the time of collection of the flower buds. A spell of dry period gives higher yield while collection made during wet weather shows a marked drop of santonine content.

As a result of the author's work at Kew, he believes that the varieties of *Artemisia maritima* found extensively in Kashmir and the trans-Himalayan region (Deosai plains) are quite different in most habitats from those found in different parts of Russia, from where the main bulk of the santonine of commerce is obtained.

Sometimes other species of *Artemisia*, especially *A. vulgaris* and *A. brevifolia*, have been commonly mistaken for the true *A. maritima*.

111. On the ecological investigation of twelve different kinds of seedlings belonging to ten families of flowering plants from the Lucknow flora, with a view to find the causes of excessive seedling mortality in nature.

S. K. MUKERJI, S. C. VARMA, *and* S. N. ASTHANA, Lucknow.

An intensive study of seedlings of a dozen species of wild plants has been carried out for some time past, with a view to find the causes of excessive seedling mortality in nature, their soil requirements and other ecological characteristics. This paper briefly embodies the result so far obtained.

A large number of seedlings of the plants mentioned below were collected from wild localities and studied both in the field and in the

laboratory. The plants selected were *Bonnaya bracheata*, *Vandellia crustacea*, *Scoparia dulcis*, *Sida veronicifolia*, *Blumea hieraciia* var. *Hamiltonii*, *Eugenia jambolana*, *Phyllanthus Niruri*, *Rungia parviflora* var. *pectinata*, *Amaranthus viridus*, *Typhonium trilobatum*, *Commelina bengalenis*, and *Portulaca quadrifida*.

Fresh weight, dry weight, ash content, rooting depth and average height of a number of bunches of a hundred seedlings each collected at random in nature were determined. At the same time soil samples were taken for analysis from the very localities from where seedlings were collected in order to find out the correlation of the principal soil factor with the growth and mortality of seedlings in nature.

An interesting correlation has been found to exist between the ash content of the seedlings of *Bonnaya bracheata* and *Vandellia crustacea* and the total carbonate content of the soil where they grow. Other factors being alike, the ash content of these seedlings was high (10·9 per cent.) where the total carbonate content of the soil was low (·466 per cent.) and *vice versa*.

The hydrogen-ion-concentration of the expressed sap of all the twelve kinds of seedlings was examined and it was found that the sap was in majority of cases acidic—*Eugenia jambolana* giving most acidic reaction with pH 4·2. The sap of *Sida veronicifolia* gave an alkaline reaction pH 7·3.

In competition between seedlings of different species, growing densely together, soil factors, e.g., carbonate content, water content, organic content and hydrogen-ion-concentration, appear to exercise a decisive influence. Some species prefer high carbonate content while others cannot tolerate an excess of carbonate. Thus, e.g., seedlings of Bonnaya, Vandellia and Portulaca are able to oust those of Rungia and Sida from soils where carbonate content is high. In this way, dense masses of seedlings die down to the ground before attaining maturity because the balance of edaphic and climatic factors happen to be against them in the struggle for existence which is very keen at this stage in their life-history.

112. A short note on the floating vegetation of the Loktak Lake, Manipur.

K. Biswas, Calcutta.

Loktak Lake is the centre of attraction to some of the naturalists and tourists for its harbouring interesting associations of flora and fauna and for its panoramic beauty. It presents indeed a charming spectacle with its rocky islands and masses of floating vegetation—surrounded as it is by taller hills and covered with fairly thick evergreen forests and grassy slopes.

The general vegetation in the higher ranges of the Naga Hills through which the Loktak in Manipur is reached bears a remarkable similarity to the Sikkim Flora.

The Loktak Lake is mostly covered with floating islands of vegetation of which *Polygonum orientale*, *Oryza sativa* with *Hydropyrum latifolium*, *Ceratopteris thalictroides and Trapa natans* and *T. bispinosa* are the predominant, larger, and taller members. Invasion of *Eichornia speciosa* of late years in shallower and more open areas has reached to such an extent that they are replacing the indigenous species which generally form, by means of their runners, an impenetrable network of vegetation on the water harbouring in their interstices delicate plants such as *Utricularia flexuosa*. The submerged *Hydrilla verticellata*, *Ceretophyllum demursum* are also abundant. Floating in between the network are observed *Lemna trisulca*, *Lemna paucicostata* and *Ricciocarpus natans* reported only to occur in Dal Lake and Peshawar by Prof. Kashyap. The algal vegetation especially the Desmid flora is very rich. Details of the aquatic Flora have been discussed in the paper.

113. The hydrophytes of Dacca and some notes on their observation.

H. K. DATTA, Dacca.

The hydrophytes of Dacca are not different from those of the other parts of Bengal. Peculiarities, noted in the case of some of them, have been recorded. Of these some are very conspicuous. *Hygrophyla polysperma* grows both as a land-plant and a water-plant. Individuals of a species of Ottelia have been found, which bear staminate flowers only. *Aponogeton crispum* is supposed to bear submerged leaves only; but plants of this species have been collected, which bear floating leaves as well. A list of the species arranged in families is given below.

114. Xeromorphism of *Pluchea lanceolata.*

N. M. MUKERJEE, Agra.

A feature which cannot possibly be noticed in herbarium specimens and consequently omitted in the Floras. Besides other xerophytic character the leaves of this plant permanently assume the 'Profile position' by twisting at the leafbase thus presenting only their edges to the incident ray and avoiding excessive heating effect of strong sunlight.

MISCELLANEOUS.

115. Notes on the teratology of certain Indian plants. XIV.

T. C. N. SINGH, Benares.

The author describes abnormalities in the following species of vascular plants :—

Marsilea quadrifolia (from Gohuan) : The occurrence of one to six pinnae in a leaf.

Vitis vinifera L. (from Simla) : Fasciation of the peduncle.

Cucurbita moschata Duchesne (from Cawnpore) : The germination of the seeds had already taken place *in situ*. Curiously enough the leaves of such seedlings (enclosed on all sides by the fruit wall) were green.

Erigeron canadensis L. (quite wild in the Naini Tal Hills) : Fasciation of the stem and peduncle.

Tagetes erecta (from Sarnath near Benares) : Peculiar fasciation of the stem, peduncle, capitula and the individual florets.

116. Notes on the teratology of certain Indian plants. XV.

B. N. SINHA, Chapra.

The author describes fasciation and certain peculiar outgrowths in fruits of the following three species belonging to the families Cucurbitaceae and Solanaceae :—

(*a*) *Cucumis Melo* Linn.
(*b*) *Cucurbita moschata* Duch.
(*c*) *Capsicum annuum* Linn.

Actual specimens will be demonstrated.

117. On the teratology of certain Angiosperms.

K. L. SAKSENA, Gwalior.

I. Fasciation of two roots of *Raphanus sativus* has been found. The radical leaves are situated in two groups on two reduced stems.

II. 1. Double and triple leaves of *Piper Betle* with two or three tips have been described.

2. The compound leaves of *Bryophyllum proliferum* possess an abnormal terminal lobe which enlarges towards one side and occupies the position of one of the leaflets in the immediately next pair. Thus the number of leaflets becomes two or four instead of three or five respectively.

3. (*a*) Fasciation in the leaflets of a trifoliate compound leaf of *Aegle marmelos* has been recorded.

(*b*) The terifoliate compound leaf of the above plant becomes tetrafoliate by the addition of a fourth leaflet.

4. The compound leaves of *Melia Azadirachta* indica have developed a huge lobe at the base of each leaflet in the basal pairs and suggest the formation of a bipinnate leaf by taking a further step which may probably result in the complete incision of the leaflets.

III. From syncarpous opistil, abnormal growths occur in the fruits of :—

(1) Hibiscus esculentus, and
(2) Carica Papaya.

118. A short cut to nectary in *Cestrum fasciculatum.*

B. N. SINHA, Chapra.

An interesting case of short cut to nectary was observed by the author while on a trip to Naini Tal. An insect was noticed cutting irregular (mostly circular) holes at different levels on the corolla-tube of *Cestrum fasciculatum.* In this species the corolla-tube at maturity is nearly half-way full of some sweet fluid secreted by the nectary gland situated at the base of the ovary. When cut the juice oozes out of the holes and is heartily sucked by the insect.

119. On the occurrence of *Cuscuta* on ferns.

T. C. N. SINGH, Benares.

Quite a large number of representative ferns growing in nature in the Naini Tal Hills have been experimented upon to see the behaviour of *Cuscuta* on them. It was rather interesting to note that *Athyrium selenopteris* Kunze was the only species to be attacked by the parasite. At the point of contact, the haustoria were formed, which as usual pierced through the tissue of the host. But all the same the attack was not of such a severe nature as it was observed on the neighbouring grasses and other flowering plants.

120. Morphology and anatomy of the root-nodules of a few leguminous plants of Lahore.

R. C. SAWHNEY, Lahore.

Nodules of about twenty leguminous species of Lahore were collected. They vary greatly in size, colour and shape not only for different species, but even for the same plant. Nodules of five species, viz., *Mellilotus indica, Medicago denticulata, Trigonella faenum-graecum, Lathyrus aphaca* and *Albizzia lebbek* were studied in detail.

Melilotus indica and *Medicago denticulata* when grown in agar containing nitrogen free culture solution form nodules of any appreciable size after three weeks of the opening of the first true leaves. Hence, in these two species at least the appearance of the first nodules does not coincide with the opening of the first true leaf as was observed by Thornton for *Medicago sativa* grown in nitrogen free sand culture.

The anatomy of the nodules of the five species is very similar. Particularly alike is the central bacteroidal tissue. The cells in this region in contrast with the surrounding uninfected parenchyma are swollen and each

has a large central vacuole surrounded by protoplasm containing bacteria. Nuclei, where they have not yet been degenerated, are larger than those of the surrounding uninfected cells. Vascular bundles for the nodule arise from the proximal poles of the root-stele and run along its length in the uninfected outer parenchyma in a more or less sinuous course.

The organisms which by their infection induce the host plant to so similar growth response need not be separated into different groups.

121. Occurrence of peculiar bodies in the rhizomes and petioles of certain Indian ferns.

T. C. N. Singh, Benares.

A number of boat-shaped diatom-like bodies have been observed in the ground tissue of the rhizomes of *Pteris quadriaurita* Retz., *Lastrea fuscipes* and the petiole of *Pteris pellucida*. Each of them has a centrally situated nucleus which is stained red with safranin. The cells of the ground tissue are stuffed with bodies like these.

A short discussion is devoted to the probable rôle of these organisms in the life-history of the plants investigated.

122. The commercial plantation and exploitation of Indian medicinal plants and the need for the compilation of an Indian Pharmacopœia.

S. K. Mukerji, Lucknow.

It is well known that a very large percentage of people in India living both in rural areas and in towns have to take recourse to the indigenous systems of medicine, knowing very well that the Hakeems and Vaids of the present day lack that intensive and methodical training in the methods of treatment which has been evolved as a result of scientific investigations and researches in the domain of Western medical science. The poverty-stricken classes of the rural and urban populace are too poor to buy the scientifically prepared but costly drugs of the West. It is, therefore, of the utmost importance that pure reliable and cheap pharmaceutical preparations made from indigenous medicinal plants should be placed on the market on a large scale for the benefit of the masses. For this purpose an extensive survey of the Indian drug flora should be undertaken at an early date and large number of regional maps should be prepared showing the distribution of medicinal plants in wild localities in different parts of India. Such regional surveys carried out by expert botanists will result in the compilation of an up-to-date drug flora of India.

A crying need of the times is the establishment of experimental drug farms in suitable centres. Plantations of medicinal herbs should receive unstinted support from the government and the public alike, for these farms will ensure a constant supply of medicinal herbs not only to Vaids and Hakeems but also to various research workers in the field of Pharmacology. In this connection, the author cannot over emphasize the fact that many more workers in Pharmacology should interest themselves in the investigation of the pharmacological properties of the Indian medicinal plants than are doing at present, so that their investigations may, in the near future, lead to the compilation of an Indian Pharmacopœia. There is also a great need for regulating co-ordinated research work along definite pre-arranged lines by a committee of experts consisting of botanists, chemists, physiologists and pharmacologists.

The vernacular nomenclature of Indian medicinal plants is in a hopeless mess. Early steps should be taken to standardize nomenclature, and the aim should be to assign one definite name to each species of medicinal plant, by which it will be known throughout the length and breadth of India.

The author's object in submitting this paper is to stimulate interest in this branch of botanical science.

123. On the 'Root-thorn' of *Bridelia pubescens*, Kurz.

P. Parija *and* P. Misra, Cuttack.

Aerial roots were noticed in August and September, 1930, on the main stem and some of the branches, growing at right angles to their axes. On some of the old roots which had changed into thorns, aerial branch roots were noticed.

The rate of growth was found to be nearly the same every day (·05 to ·1 mm.) till the cessation of growth.

Such a root, growing a few inches above the soil, was covered with earth, the root turned white, the rate of growth went on increasing daily and last of all it went down into the soil.

One of these roots was covered in a moist dark chamber, the rate of growth in it was slightly greater than in a normal root, till ultimately the growth ceased.

By November all the roots had changed into thorns, the apical point having become sclerotic; but the bark still remained green. The root-thorns ranged from 3 cm. to 6 cm. only in length.

Longitudinal section of the apex of a young root was examined. It had a root cap, calyptrogen extending back into a many-layered epidermal tissue, periblem and plerome.

Transverse section of a young as well as of an adult root was examined. Many-layered epidermal tissue with an internal limiting layer was found. Other portions were similar to that of an ordinary dicotyledonous root, excepting that the stele was polyarch. Secondary growth took place as in other dicotyledonous roots in the stele; but phellogen formed in the outermost layer of the cortex just below the dermal limiting layer, so that the green primary cortex persisted even in the thorn in the older region below the thin bark. Most of the cells of the cortex, all the cells of the endodermis and some cells of the secondary phloem were full of tannin.

124. On Tylenchus sp. forming leaf-galls on *Andropogon pertusus* Willd.

S. V. Vankatarayan, Bangalore.

Galls on the leaves of *Andropogon pertusus*, a common pasture grass, were noticed in Bangalore, Chikmagalur, Coimbatore, and Palghat in S. India. Besides the leaf-blades they were found to occur on leaf-sheaths, the culms and the axis of the inflorescence. The galls are purple in colour, involving the whole thickness of the leaf, but more prominent on the under surface than on the upper. They are globular or oval varying from 0·5 to 1 mm. in diameter. Affected leaves are curiously distorted and sometimes they roll so tightly as to hold firmly the tip of the younger leaves.

The galls contain a number of eelworm eggs, larvæ and adults. The tissues of the gall include four or more veins and the tissues between them, with a ring of sclerenchyma surrounding the chamber.

The nematodes belong to the genus Tylenchus, but the exact species has not been determined. There is no mention in literature of any Tylenchus on any grass in India.

125. Life-history of Gleichenia Dichotoma. Part I.

M. A. Sampathkumaran *and* A. R. Gopalaiyengar, Bangalore.

This preliminary paper deals with the development of the sexual organs, Syngamy and the segmental cleavages of the young embryo.

The development of the Antheridium conforms to that of the Osmundaceae. The first division results in a basal cell, the next one being the funnel wall. The central cell divides a number of times producing the spermatogenous tissue from which numerous sperms develop. The origin

of the blepharoplast normally supervenes at the third mitosis of the spermatocytes. The fate of the blepharoplast from its appearance as a small globular structure, through the rhomboidal shape to the ultimate cilia producing body of the sperm has been traced and it offers striking similarities with that found in Nephrodium.

The Archegonia arise at the sides of the growing point profusely, several of them being shifted to the flanks of the midrib. The development of the Archegonium is like that of the other Leptosporangiate ferns. Prior to the separation of the primary neck canal cell,. the central cell becomes elongated. The outer cell dividing by transverse walls gives rise to four primary neck cells which ultimately produce four long necks having about eight to ten cells in each row. The ventral canal cell is differentiated from the egg cell and the neck canal nuclei divide into two. A distinct wall appears between the two nuclei thus suggesting a condition found in the Marattiaceae. There are glandular hairs found close to the Archegonia.

At the time of Fertilisation the ventral canal cell degenerates and the cell partition separating the two neck canal nuclei also disorganises. The egg remains at the bottom of the archegonial cavity, its nucleus exhibiting the characteristic resting state.

The perm after effecting entry through the neck enters the egg and fuses with it. Disintegration of the sperm commences after fusion is complete and the sperm loosens itself into the complex reticulate structure during Syngamy, which later becomes gradually homogeneous. A wall is soon formed around the zygote and the zygote remains in this condition for some time without undergoing any segmentation.

The segmentation of the Embryo takes place in this state and the first mitosis supervenes followed by a vertical wall as in the Polypodiaceae. The quadrant wall is at right angles to the basal wall. The epibasal quadrant gives rise to the stem and leaf and the hypobasal to the root and the foot. The procambial strands take their origin as scalariform tracheids at a region a little removed behind the stem apex and above the foot, and leading towards the root.

A discussion of the phyletic progressions and the affinities of the Gleicheniaceae is included in the paper.

126. Meiotic cytokinesis in *Michelia champaka.*

M. A. SAMPATHKUMARAN *and* A. R. GOPALAIYENGAR, Bangalore.

It is increasingly becoming recognised that cell partition is effected by furrowing processes in many of the higher flowering plants. The development of *Michelia champaka* offers an interesting case in which meiotic cytokinesis is effected by means of cleavage furrows.

For obvious reasons, the development has been observed from the late Diakinesis. During diakinesis the number of gemini were 19. The number of bivalents at the metaphasic plate are distinctly nineteen. Hence this represents the haploid chromosane complement. The bivalents begin to separate along their line of contact and migrate to the poles of the spindle. The spindle itself takes its origin within a definite peri-nuclear mantle, the mantle appearing close to the region of the now defaced nuclear membrane. The chromosomes after reaching the poles in the usual fashion become completely reconstructed. By the time the daughter nuclei are organised and the spindle fibres resorbed, a cleavage furrow begins to make its appearance in the plasma membrane at the opposite sides of the equator of the microsporocyte. The furrow does not effect a bipartition, but after advancing centripetally towards a short distance remains inhibited until after the completion of the second division.

After interkinesis the nuclear membranes of each daughter nucleus disappear and the univalent chromosomes become oriented on the homotypic spindles which may be either parallel (quadrate) to, or at right angles (decussate) to each other. The chromosomes pass to the poles

and during the Ana and telophases the 19 chromosomes can be counted. The chromosomes after reaching the poles, soon develop a nuclear membrane and secondary furrows appear as sharp incisions across the equator of the homotypic spindle. The cell wall deposition takes place as a jelly like mass as the furrows are beginning to be formed. It is at this 'teranucleate stage' that the arrested primary heterotypic furrow advances inwards effecting a separation of the mother cell. The secondary furrows subdivide the four microspores.

The nuclear membrane seems to exercise a great influence during the furrowing as the resumption of the homotypic furrows only supervenes after the nuclear membranes of the daughter nuclei of the second division are completely organised.

A discussion of the theoretical considerations is also included.

127. Physiology of the tendrils of Cucurbitaceæ.

R. H. Dastur *and* M. B. Billimoria, Bombay.

The rates of respiration of the straight, stimulated and curled tendrils are measured. No increased output of CO_2 is obtained when the tendril curls after stimulation. Similarly no increase in the internal temperature of the tendrils is noted.

128. The effect of polarised light on the formation of carbohydrates in leaves.

R. H. Dastur *and* R. D. Asana, Bombay.

An apparatus is devised to study the rate of photosynthesis in polarised light and in the normal light. Plane polarised sunlight and plane polarised artificial light are used. The rate of photosynthesis is determined by determining the different carbohydrates formed. No increased formation of carbohydrates is observed in polarised light.

Section of Geology.

President:—P. EVANS, ESQ., B.A. (CANTAB.), F.G.S., A.M.INST.P.T.

Presidential Address.

GEOLOGICAL SURVEYING IN JUNGLE COUNTRY.

CONTENTS.

LIST OF ILLUSTRATIONS.

I. Introduction.

1. Geological surveying has a fairly extensive literature, as may be judged by the bibliography in one of the most recent volumes dealing with the subject—Greenly and Williams 'Methods in Geological Surveying', but many of the books thereon are concerned almost entirely with a few specialized methods of work applicable to the types of country and structure familiar to their authors. American literature on geological mapping devotes a large amount of space to petroleum work, especially to the determination of structural details in areas of almost horizontal beds. Books such as those of Hager, Lahee, and Cox, Dake and Muilenberg make special reference to mapping based on the tracing of key beds by plane-tabling. Amongst British authors, Cunningham Craig and Lister James, both with experience in Burma, have described methods of work in which the compass and map-case are employed; mapping in moderately or sharply folded areas is accorded much more consideration than it is by the American authors. Cunningham Craig describes methods used in moderately open country, but does not discuss in any detail the procedure to be adopted in areas covered with dense jungle. Although Lister James refers to a very specialized method of work found useful in certain types of jungle country he does not deal fully with ordinary mapping in such areas. Greenly and Williams deal mainly with large-scale mapping in moderately open country of which topographical maps already exist but their book is of great value to all interested in geological survey work. Geological mapping in thickly wooded areas does not seem to have been discussed in any detail and as I have, for a number of seasons, been engaged in field work in the jungle-clad hills of Assam, it seemed not out of place to endeavour to summarize the methods which have proved useful in geological surveying in jungle country.

2. The methods adopted during the geological survey of any new territory must be influenced by the topography, whether desert or jungle, hill or plain, by the tectonics and stratigraphy, and by the objects of the survey. This address is limited to a consideration of the methods applicable to densely forested country of moderate or high relief where the rocks have been subjected to fairly strong earth movements. Although the survey of Assam with which I have been connected has had as its object the study of the petroleum resources of north-east India, the mapping has been directed towards the elucidation of the structure and stratigraphy of almost the whole of the sedimentary rocks of the province, so as to provide an adequate geological foundation for specific recommendations concerning the testing and economic development of the oil resources of this part of the country.

To this extent, therefore, the methods of mapping to be discussed are not specially restricted to work to which the term 'prospecting' is usually applied.

II. Types of Mapping.

3. The geological mapping of a large territory may be divided into three sections:—

(*a*) the preliminary reconnaissance,
(*b*) extensive small-scale mapping,
(*c*) detailed mapping of selected areas.

4. The preliminary reconnaissance will give some indication of the nature of the difficulties to be encountered, and of the types of structure, and range of strata to be dealt with. Opportunity will naturally be taken to link up with areas previously visited by geologists either within the territory or nearby.

5. The extensive systematic mapping of large areas on a scale of, say, one inch to a mile should logically follow the reconnaissance but in economic work it is often necessary to proceed at once to the detailed examination of selected areas. The systematic mapping will reveal the general structure and stratigraphy of the area and give some indication of the probable mineral wealth.

6. The detailed mapping will usually be restricted to areas of possible economic importance or in which important structural or stratigraphical problems have to be investigated. The scale chosen will be determined by the nature of the country and by the objects of the work, and may be, for example, 4, 6, 8, 16 or more inches to a mile. As an example, in the case of Assam, as a result of the reconnaissance, a quarter-inch map was produced; systematic mapping has been on the one-inch scale and detailed mapping mostly on the eight-inch scale, the sixteen-inch scale being used in special circumstances.

7. The three types of survey naturally merge into each other; traverses during preliminary reconnaissance will be incorporated in the subsequent systematic mapping, and during the course of this mapping certain small areas may be worked over in a 'semi-detailed' manner, lacking the rigorous nature of a detailed survey but including more details than can be shown on a one-inch map.

8. Although the reconnaissance and small-scale survey work in a country such as Assam involve modifications of the procedure applicable to more open ground, it is in detailed mapping that methods depart furthest from those described in the text-books on geological surveying, and these form the main subject of these notes.

III. Methods of Detailed Mapping.

A. *General Nature of the Difficulties.*

9. The schemes of mapping to be described have been evolved as a result of the search for oilfields in Assam. In 1915 the Burmah Oil Company's geologists, after extensive reconnaissance work, began the investigation of those areas which appeared likely to have some economic possibilities. It soon became apparent that the methods used for detailed mapping in Burma would not be successful in Assam. There gradually grew up a technique suited to the thick jungle, and with various modifications to fit local conditions, the methods to be described have been found satisfactory in mapping a number of areas on scales ranging from 4 to 16 inches to a mile.

10. The work involved in making a geological map can be divided into two parts, not very distinct if the area be open country, but more clearly separate in the jungle country which is typical of Assam—(*a*) constructing the topographical basis, (*b*) recording the geology. It rarely happens that the existing maps of an area are a sufficient ground-work for the geological map. Cadastral maps of hill and jungle areas are seldom to be had; if available they lack detail and furthermore are not very accurate. The half-inch and one-inch maps are very inaccurate in detail. Usually the geologist has to make up his own map, starting on a blank sheet of paper, and it is with this type of work that these remarks are concerned.

11. Before passing to a description of the methods used, first to produce a skeleton topographical map and then to add the geological body, it is desirable to describe briefly the kind of country in which the work is to be done, as methods applicable to one type of country are likely to be quite unsuitable elsewhere.

12. The area to be mapped may have fairly high relief—the topography of most of Assam is immature and the hills, whether high or low, are steep; the hill-streams alternate between series of waterfalls and rapids and alluvial stretches in which the stream is aggrading its course. The hills encountered in detailed mapping are seldom more than 500 or 1,000 feet in height but slopes of 1 in 3 are common. In many areas there are large alluvial tracts from which the hills rise abruptly. Exposures are almost entirely restricted to the beds of lesser streams. Many of the large rivers run for miles in alluvial plains devoid of exposures, and although some of these rivers give good evidence in their upper reaches, it is the smaller streams that provide the geologist with most information. Flowing down the hillsides, often with very steep gradients, many of these *nalas* give excel-

lent exposures although others are choked with boulders. The hillsides are thickly covered with soil and it is only rarely that the underlying rock is seen protruding through the soil cap. In some areas a little rock debris can be seen to indicate what is below, but in most places very little help can be had in this way.

13. One of the great obstacles is the jungle. In places there is tree jungle with moderately thin undergrowth, in a few other areas there is tall grass which may or may not be a great obstacle, but these are exceptions and in most of the Assam jungles the vegetation—whether bamboo, thorny cane, ageratum, '*san*' grass, or a more varied assemblage—is so thick that it is impossible to see more than a few yards ahead, and in the worst cases visibility is reduced to a foot or two. Through this thick forest progress is very slow, one's rate must be measured not in miles per hour but in hours per mile and it generally pays to keep to ridges (which are sometimes elephant tracks) or to the streams. Where villages exist, the village paths may be a help in getting from camp to the site of one's work but are too few and far between to be of much assistance during the actual mapping.

14. The thick jungle makes it difficult to get a bird's-eye view of the area that is being mapped, and although occasional glimpses may be caught from chance clearings or from the top of a steep slope or obtained by climbing a tree, it is not unusual for a map to be completed without the geologist ever seeing the area as a whole.

B. *Methods of Preparing the Topographical Map.*

15. Having thus briefly reviewed the nature of the country and some of the difficulties associated with work in jungle-covered tracts, it is now possible to discuss the various methods used to prepare the necessary topographical map. Although the reconnaissance or systematic small-scale mapping preceding the detailed work will have given some indication of the structure of the area selected for detailed mapping, it may be expected that, unless the geologist was himself concerned in the preliminary examination, he will wish first of all to spend some time in examining a number of sections within and near his area. This work of familiarizing himself with the problems before him can most conveniently go on during the early stages of preparation of the topographical map, provided that the more mechanical parts of the topographical survey work are being done by assistants, a method which has been found very convenient for detailed mapping in country such as Assam.

16. *Framework.*—The choice of methods of making the topographical map must depend on the type of country.

In any case the finished map should show the main watersheds, all the important and some of the unimportant streams and such paths as there may be, also, in some cases, limits of cultivation, sites of hamlets, and so on. This topographical map cannot, of course, be built up haphazard but must have some scheme of framework or control to insure against large errors. For surveying the details of the map—streams, paths, ridges—there is little choice; any convenient type of compass used in conjunction with either a tape or chain is so much superior to any other method that detailed discussion is not required. Although there is very little room for choice of method of surveying the streams, ridges, etc., quite a number of methods are available for the 'control' and at a very early stage in the work the geologist must decide what type of framework will be used for his map. There are available the following schemes:—

1. Triangulation by:—
   - (*a*) plane-table,
   - (*b*) theodolite,
   - (*c*) compass.

2. Traversing by:—
   - (*a*) theodolite,
   - (*b*) compass.

(1) *Triangulation.*

17. A triangulation method is simplest and most accurate where it can be employed. It is not likely to be successful unless the relief is high or there are a number of strips of open (cultivated) ground.

18. In a favourable case it may be possible to find a suitable base line in a cultivated alluvial stretch along the outcrop of a soft bed or along a denuded anticlinal crest, or perhaps in the bed of a large river. If so, a base line running through a large part of the area is set out by theodolite or plane-table—the line preferably not being straight, but composed of a few sections on different bearings. In two instances in Assam it was possible to use minor trigonometrical stations of the Survey of India as the ends of a base line. A ridge traverse made carefully by tape and compass may be a suitable substitute. From the ends of the line, and from a number of points along it, sights are taken on to neighbouring hills. Unfortunately in jungle country it is nearly always necessary to 'flag' the points to be sighted on—otherwise it is impossible to recognise individual trees from a great distance and from very different angles or to identify them on the ground. The theodolite, plane-table or compass can be used for this work but the latter is not very accurate unless the sights are short and there are a fair number of check intersections—neither condition being likely in jungle country.

19. Provided the country permits the setting out of a base line, the primary enlargement is usually a fairly simple

matter but the extension to include points further afield is much more difficult. If the hills tend to be flat-topped it is hopeless to attempt to triangulate from them—even platforms erected in the trees sighted on may give a poor view, but if the hills tend to be conical, it may be possible to set up a plane-table or theodolite station without a prohibitive amount of jungle cutting. From these stations the triangulated framework is extended further away from the main base line.

20. This method is restricted to areas of bold relief, with a fairly simple system of drainage (e.g., a number of strike ridges) and without a great deal of tree jungle. Comparatively isolated trees in bamboo or other low jungle provide suitable points both for sighting to and observing from. The obvious drawbacks to any method of triangulation are the amount of jungle cutting likely to be required, the difficulty of choosing suitable points for flagging and the limited number of fixed points produced by the work. The advantages are accuracy and the absence of long computations.

(2) *Traversing—Theodolite.*

21. The alternative is to build up a framework or control by means of traverses. The most accurate traverses are, of course, theodolite ones but adequately checked theodolite work is slow in hilly jungle country, the amount of jungle cutting required is very great, sights are likely to be shorter than is desirable, often dropping below 150 feet, sometimes below 50 feet, and the computations are somewhat laborious, and need careful checking. Provided great care is taken to avoid errors (and experience shows how easy it is for small errors of observation to mount up to an unduly large total) the method gives a large number of accurately fixed points. For preference, the traverse is laid out in approximately square blocks, these being joined together in one or more rows to form a rectangle extending throughout the area. This work can be done by men of the ordinary surveyor grade, drawing from Rs. 60 to Rs. 120 per month. When the geological survey is concerned with economic problems such as exploring the extension of a proved mineral field or the examination of an area which includes boundary lines separating land held or claimed by different interests, or where the boundaries of a concession are to be determined, a theodolite traverse framework is well worth having, but in the ordinary detailed examination of 'prospecting areas' in heavy jungle the extra cost of theodolite work is not usually justifiable. In detailed mapping having a purely scientific objective, the theodolite is not likely to be helpful in country such as that under consideration.

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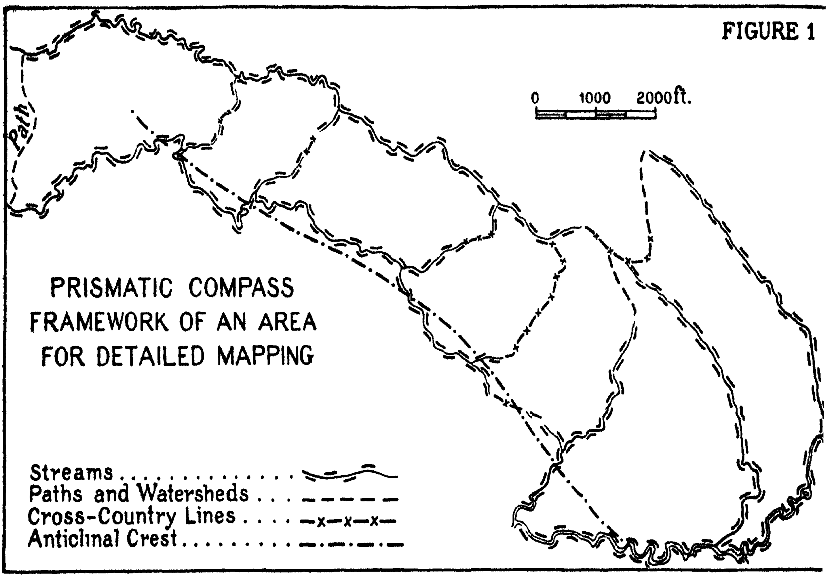
(3) *Traversing—Prismatic Compass.*

22. The most generally useful method of producing the topographical basis of the map is to build it up by a series of closed traverses made by prismatic compass, and it is proposed to explain this method in some detail. A great advantage is that a 'framework' is obtained by employing almost the same methods as are used for the traverses of the streams and paths.

23. *Personnel.*—Another great advantage of the method is that elaborately trained surveyors are not needed, the whole of the work being carried out by men drawing Rs. 30



to Rs. 40 per month plus a small jungle allowance. No knowledge of English is required but these men must know the English alphabet and for preference be able to write their vernacular in English characters. Each 'traverser' needs from 2 to 5 men to cut the jungle—the number depending on the type of country and the nature of the labour.

24. *Equipment.*—All that is needed in the field is a good prismatic compass (three to four inches diameter graduated in half degrees), a sturdy wooden stand for it, a 'metallic' tape and a hand level (either Abney or some simpler form). For office work the traverser is provided with specially designed plotting sheets. Where more than one traverser is employed, the compasses should be compared, as individual compasses may differ by a degree or more.

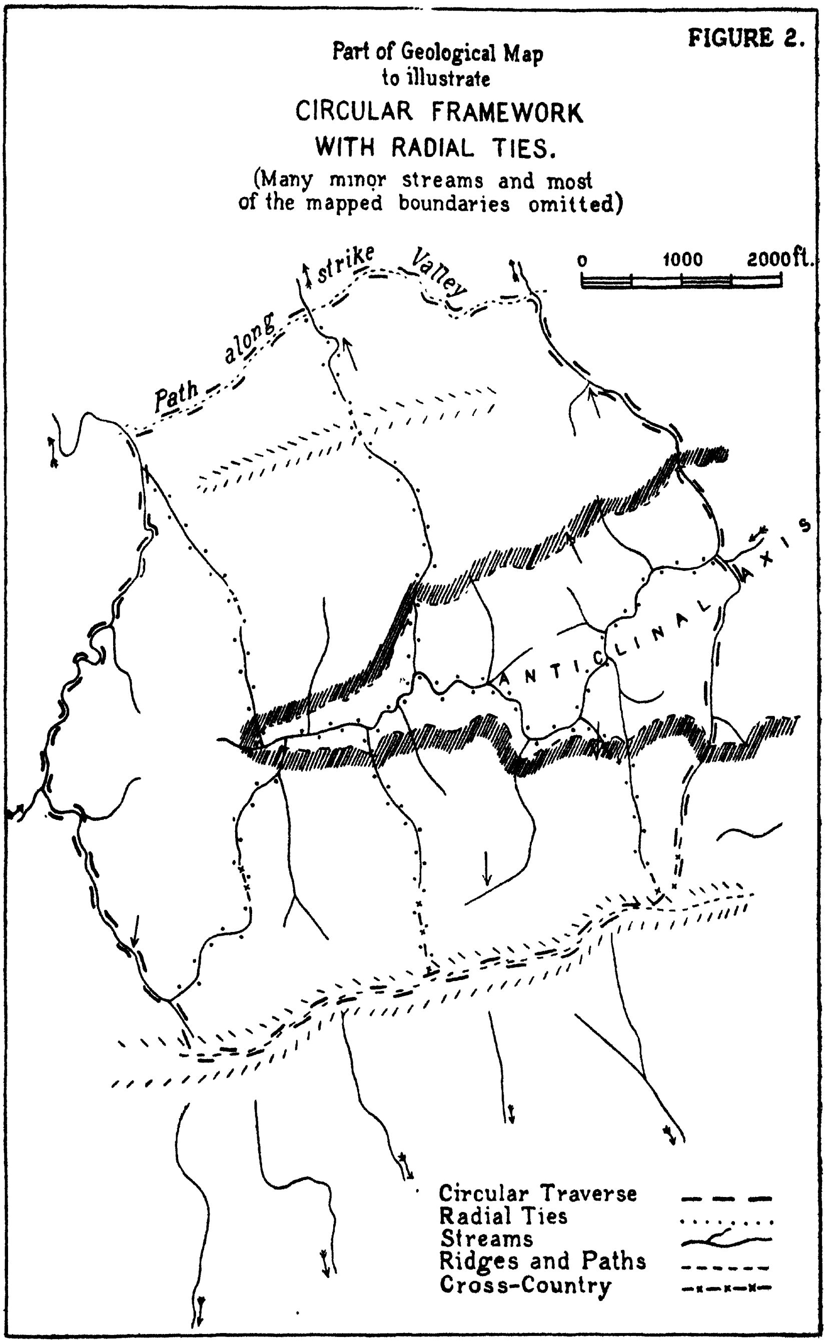


FIGURE 2.
Part of Geological Map
to illustrate
CIRCULAR FRAMEWORK
WITH RADIAL TIES.
(Many minor streams and most
of the mapped boundaries omitted)
0
1000
2000ft.
Path along strike Valley
ANTICLINAL AXIS
Circular Traverse
Radial Ties
Streams
Ridges and Paths
Cross-Country

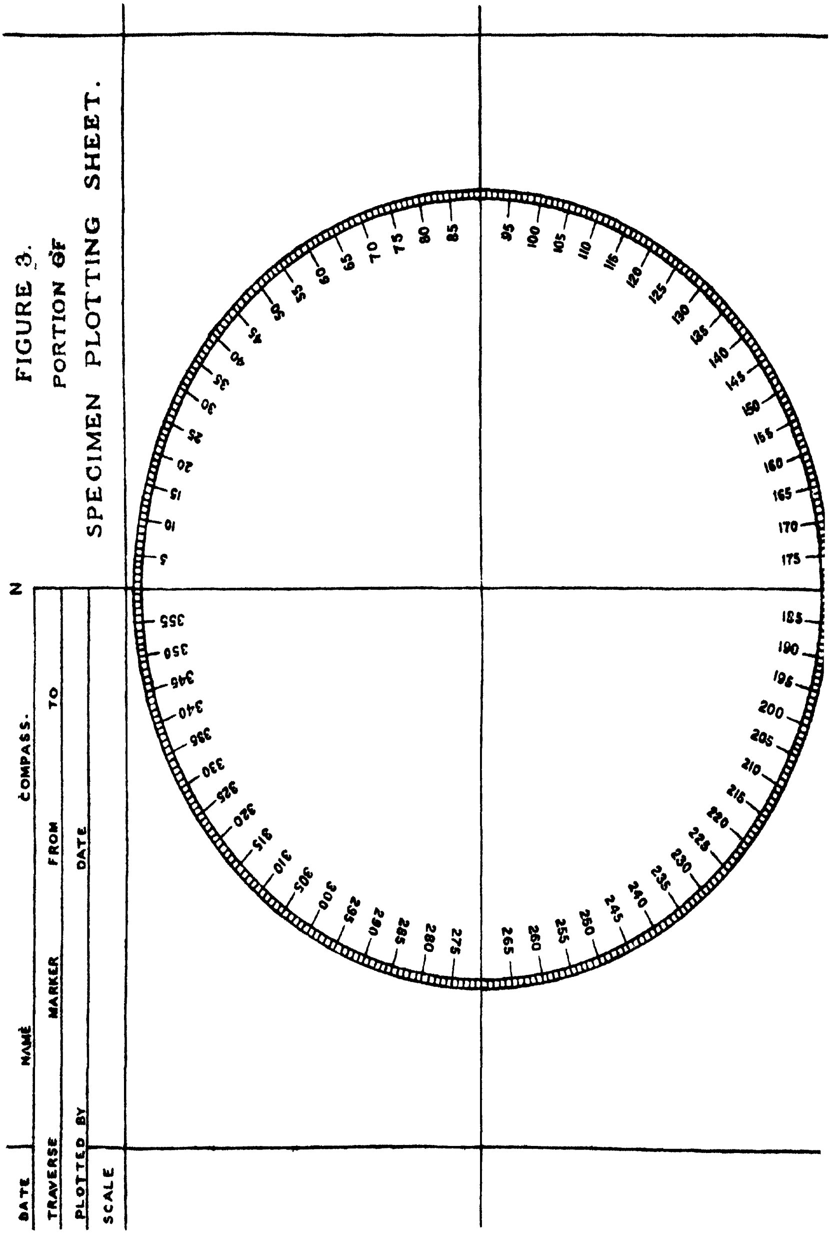


FIGURE 3.
PORTION OF
SPECIMEN PLOTTING SHEET.

25. *Arrangement of Survey.*—If a one-inch map is available this may form a guide to the general disposition of the main streams and watersheds. In the preliminary reconnaissance a certain amount of similar information will have been gained. This may be supplemented by a few additional traverses undertaken before the main scheme of the map is decided on. As soon as enough is known of the general 'lie of the land', the area, or at least the central part of it, is divided up into a number of blocks or circuits which may conveniently be very roughly squares with a side of from half a mile to a mile in length according to the scale on which the work is being carried out. In the case of the mapping of an anticline with a view to estimating the prospects of oil, a line of such mile or half-mile blocks forming a rectangle running along the crest may form a sufficient 'control'; alternatively, two lines of rectangles may be convenient, having their common side somewhere near the crest (Figure 1).

26. These blocks will not in practice approach very closely to actual squares; each side of a block or circuit will be a compass traverse and this will usually be run along a stream, watershed, or path, avoiding as far as possible any long 'cross-country' traverses. The scheme of lay-out of the circuits is of course decided on by the geologist and this offers considerable scope for the exercise of his capacity for visualising the general lie of the countryside from very meagre data It is not necessary for him to attempt to plan out in detail more than one or two blocks at a time, providing he knows that these will work into the general scheme.

27. Another method which may be adopted is to arrange the control traverses in the form of a wheel with three, four or five 'spokes' (Figure 2). This may be very convenient when several large streams meet in a small alluvial flat.

28. As soon as the first main circuit is decided on, the traversers are sent out to run a duplicate traverse in opposite directions. Each station is marked by a small lettered and numbered peg cut from the jungle by one of the coolies. Stations may perhaps be from 50 to 200 feet apart, according to the nature of the streams and ridges. The clockwise and anti-clockwise traverses are plotted separately and compared.

29. At this point it is convenient to explain a method of plotting which has been found of considerable value. The traverses are not plotted directly on to the field map but on the special sheets already referred to, devised to permit accurate plotting by the comparatively unskilled traverser. These sheets are of thin semi-transparent paper measuring 8 or 10 inches by 11 or 13 and having imprinted a circle (diameter five inches) graduated in degrees, the centre being marked by the intersection of the N.-S. and E.-W. lines

(Figure 3). The bearings are laid off by placing a set-square on the circle and transferring the direction by set-squares to the successive points of the traverse. This method is slower than the one employing a rectangular protractor but is less liable to error. From the thin paper the points are subsequently transferred to the map itself by pricking through with a fine needle.

30. Comparison of the plotting sheets of the clockwise and anti-clockwise traverses enables important errors to be seen at once; mistakes of 100 feet or 100 degrees in observing or plotting have been found to be the commonest. Where the discrepancy is in observing, the reading must be repeated. Small errors are not so speedily found, but comparison of field books is not a very long task. There are bound to be differences arising from the limitations of the method, but after getting rid of the gross errors, each version of the circuit should close within, say, 25 to 50 feet according to the length of traverse and the type of country, the mean of the two traverses providing a 'block' in which the error is small enough for most purposes.

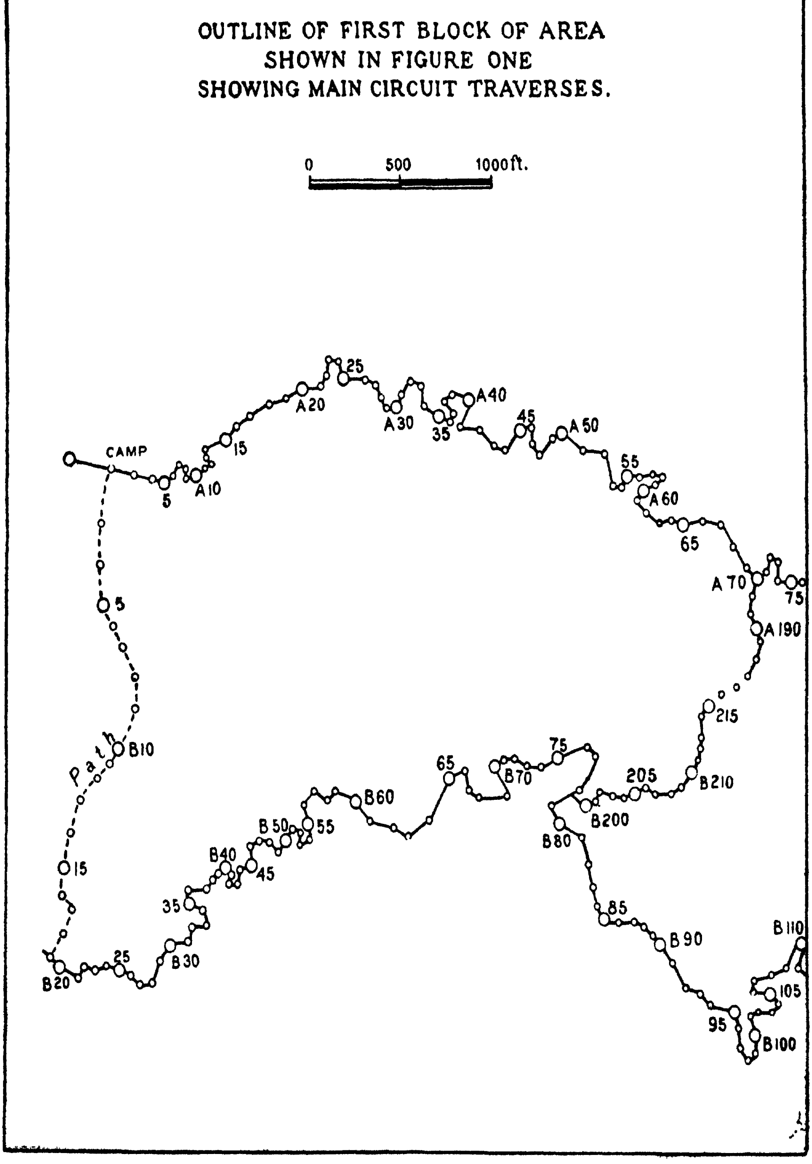
31. After resolving any discrepancies in the two traverses it is desirable for the geologist himself to plot a mean of the two on an enlarged scale, otherwise plotting errors may be more than the traversing errors. This is needed only for the main circuits, not for the subsequent work, and will probably be done with a rectangular protractor.

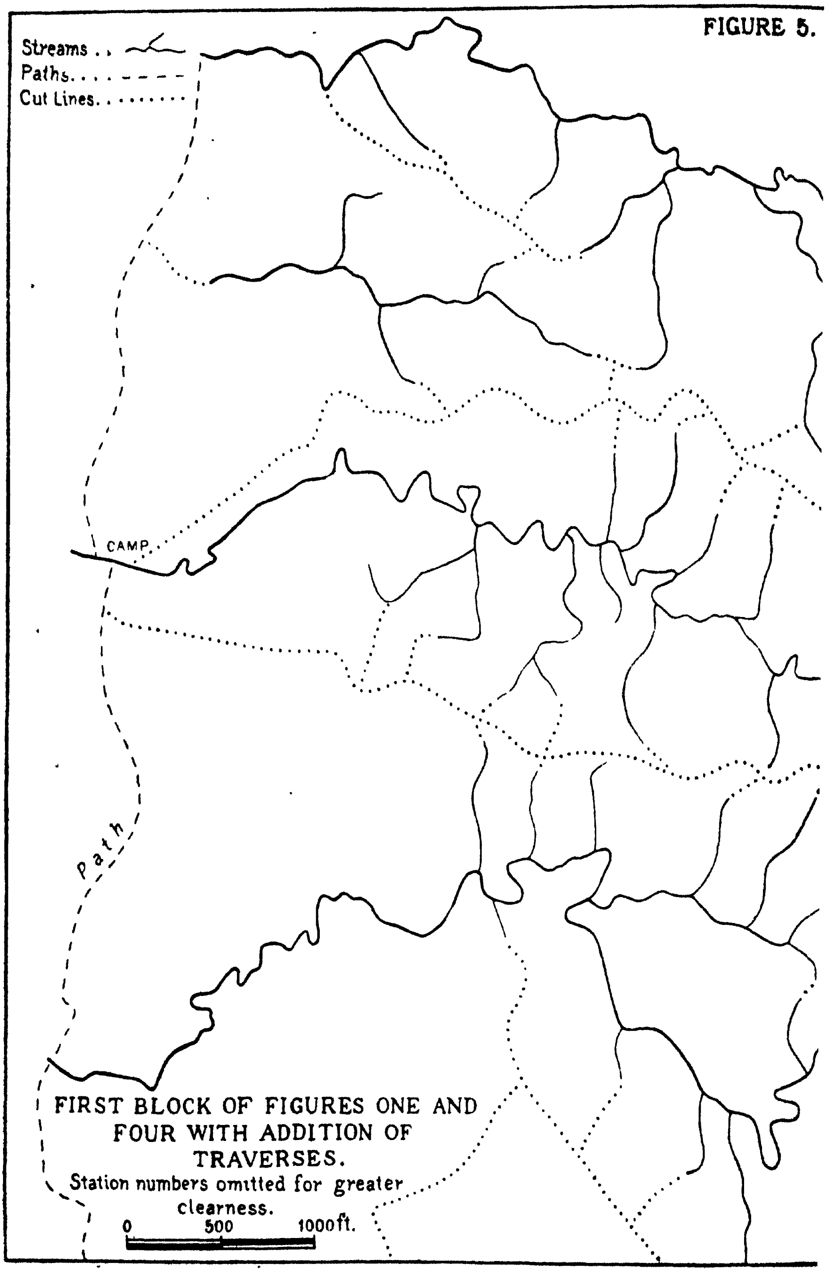
32. The next step is to draw out the actual map on which the geology will be shown. It has been found convenient to use sheets measuring 18 or 20 inches by 24 or 28 inches, made of tough paper with a medium surface capable of standing hard usage and ruled with one-inch squares. These sheets are subsequently cut into four for use in the map-case. Care must be taken in the arrangement of the map conveniently on the paper so as to avoid small parts projecting off the edge of the sheet.

33. The main traverse block (Figure 4) is first entered on the map, preferably reducing every tenth station from the large-scale plotting and pricking through the intervening points from one of the two plottings on the normal scale. It is an advantage to be able to deal with two adjacent blocks at the same time, as this allows a better distribution of errors, but this may not be feasible. All points on the field map are marked in ink (preferably red) and the number written alongside every fifth or tenth station, these stations being usually indicated by a more pronounced marking; it is convenient to distinguish in some way the main circuit points from the others.

34. Whilst the geologist is attending to the setting out of the framework of the first block or the first few blocks of the map, the traversers will be making a start with the details.

FIGURE 4.


OUTLINE OF FIRST BLOCK OF AREA
SHOWN IN FIGURE ONE
SHOWING MAIN CIRCUIT TRAVERSES.
0
500
1000ft.
CAMP
Path
A10
A20
A30
A40
A50
A60
A70
A190
B10
B20
B30
B40
B50
B60
B70
B80
B90
B100
B110
B200
B210



FIRST BLOCK OF FIGURES ONE AND FOUR WITH ADDITION OF TRAVERSES.
Station numbers omitted for greater clearness.

Any streams traversed in the very first stages (which do not form part of the main circuits) may have to be joined to the framework by short closing traverses. All subsequent traverses of importance will start from a point already fixed and be 'closed' to another fixed point. (In practice 'closing' is made to two adjacent points to avoid errors in identification.) If there should be any minor traverses of small tributaries, they will be left unclosed. Unless the traversers are very good, both backsights and foresights should be taken.

35. As soon as a reasonable amount of detail has been traversed and plotted, the streams, paths, ridges, etc., are pricked through on to the field map (Figure 5). Streams may be indicated by blue lines and paths and ridges in red. There should be plenty of checks against errors by the system of 'closing' and any large error will show up at once by failure to 'close'.

36. The 'density' of detail traversed must depend greatly on the nature of the problems to be solved, and no general rule can be given. It is essential to arrange that the traverses are fairly evenly spaced and also that no big stream remains untraversed; a mistake that traversers are prone to make is to traverse a large number of very minor streams in one part of the area leaving other parts nearly blank. Where it is known beforehand that special attention has to be given to one portion of the area, extra traverses can be arranged for.

37. The next stage is to enter on the map as much as possible of the geological information gained during the reconnaissance work carried out whilst the traversers were busy with the main framework, and as soon as this has been done, the large sheets are cut into smaller sheets to fit the map-case. A size of $9'' \times 12''$ is very convenient, four of these go to a large sheet, after discarding a small outer margin which is a convenience during the construction of the topographical map. The field sheets should fit together without overlap; each should bear a number and carry an index to show its relation to the rest of the map. It is usually best to arrange the sheets so that they are not 'staggered' but have all dividing lines running N.-S. and E.-W. right through the map.

C. *Tracing of Boundaries.*

38. The geologist is now ready to resume field work and begin the actual detailed mapping. His reconnaissance will have given him a general idea of the succession and structure unless the area is a very complex one, in which case the earlier work may merely have shown where the difficulties will require careful study. In most cases a few strong beds will have been found which will provide the sub-groups that he will attempt to follow on the ground.

39. The first stage of the actual detailed mapping may perhaps be a continuance of the reconnaissance, consisting of working systematically over the largest streams in the area. All dip evidence and lithological notes are entered directly on the field map and the note book is used as little as possible. The geologist has with him a map-case, scale, pencils, clinometer-compass, tape, hammer, chisel, collecting-bags, lens and possibly aneroid. Methods of recording work vary with individual preferences, some preferring to use coloured pencils to indicate lithology and others relying on abbreviations such as s, c, l, etc.

(1) *Choice of Sub-groups for Mapping.*

40. The examination of the main streams, whether in the reconnaissance or in the first stage of the detailed mapping will usually give a very good indication of the succession and will have shown the geologist which beds or groups of beds are most suitable as markers. At this stage he will do well to commence from one end of the area and carry on the mapping of these selected beds.

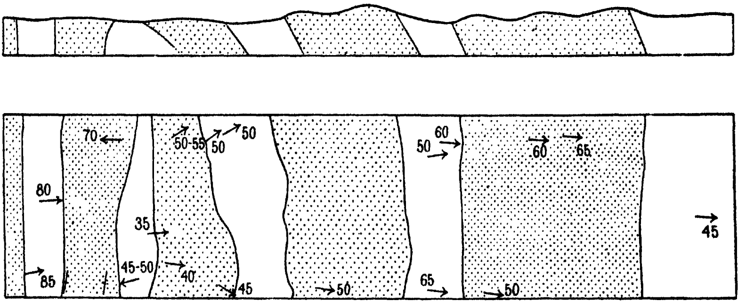
41. The sub-groups chosen for mapping should as far as possible be natural lithological divisions, but where there is a great thickness of rapidly alternating beds it is clearly impossible to attempt to map each narrow band; in such instances one can usually find some groups of sufficiently prominent beds which can be followed, at least for some distance, or alternatively one can choose well-marked thin bands of slightly different hardness or coarseness which can be traced for a fair way. No general rule can be given for the ideal thickness of sub-groups chosen for mapping; naturally, for the larger scales, smaller thicknesses are desirable, but the intricacies of the structure and the steepness of the dip must always be considered. The actual sub-groups chosen will of course be greatly influenced by the nature of the succession, and may depart considerably from the ideal.

42. A few actual examples may perhaps be quoted; for mapping on the eight-inch or sixteen-inch scale I have usually found that boundary lines could conveniently be spaced at stratigraphical intervals of 200–500 feet; a smaller interval being desirable with gentle dips or where great detail was required and a larger interval with steeper dips or where little detail was required, as, for example, well out on the flank of an anticline. On the other hand, in one area, a bed less than a foot thick proved a valuable sub-group for mapping and in other instances no persistent boundaries have been discoverable through several thousand feet of beds. In such areas, it may be necessary to fall back entirely on local bands which can be traced for a few hundred feet. These give valuable

clues to the general trend of the strike lines but are a poor substitute for regularly mapped groups.

43. In mapping one area on the sixteen-inch scale (Figure 6) the following spacing interval was used, being determined by the existence of well-marked natural boundaries:—900, 200,

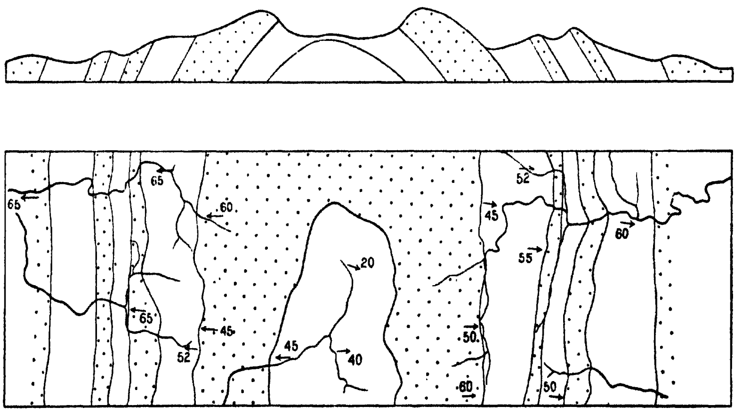
FIGURE 6.



SECTION AND PLAN TO ILLUSTRATE SPACING OF MAPPED BOUNDARY LINES.

0 50 1000 ft.

FIGURE 7.



SECTION AND PLAN TO ILLUSTRATE SPACING OF MAPPED BOUNDARY LINES.

0 2000 4000 ft.

500, 250, 250, 100 feet, the 900 feet interval being down the flank of an anticline and 100 feet the stratigraphical distance

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of the first boundary line above the lowest exposed horizon on the crest of the fold.

44. In another anticlinal area (Figure 7) mapped on the eight-inch scale, the corresponding thicknesses between the chosen boundaries were:—600, 200, 400, 200, 600, 800, 500 feet.

45. It may happen, when a comparatively thin group of beds forms a useful marker, that two boundary lines close together can be mapped with very little greater expenditure of time than would be needed to map either line, this is particularly likely to be the case when, instead of natural sub-groups, it is necessary to choose, somewhat arbitrarily, certain bands of, for example, clay in a thick sandstone or thin sandstones in a thick shale.

46. Where lateral variation is very pronounced it may be necessary, at least in the early stages of the work, to record and trace the top and bottom of every band. As work proceeds the more persistent bands will be discovered and these alone followed.

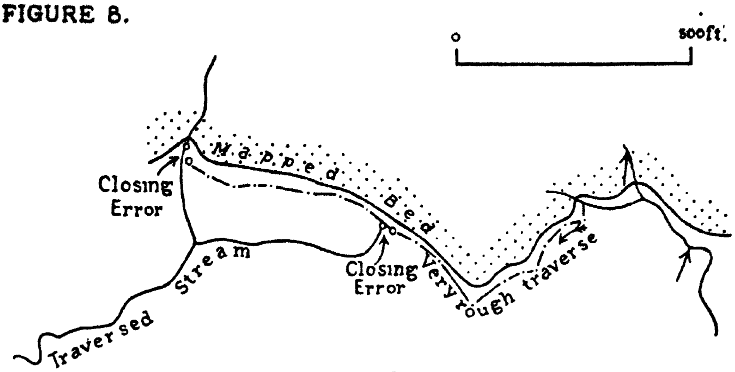
(2) *Procedure during Mapping.*

47. When the various boundary lines to be followed have been decided upon, the geologist must sketch out a plan of campaign. Much will depend on the relationship of topography to structure and the degree of difficulty in getting about in the area; where at all possible, he should aim at keeping the map compact and avoid having scattered patches of unvisited ground.

48. Choosing first the most clearly-marked boundary line, as for example the line between a thick hard sandstone and underlying clay or shale, he starts from a large stream and endeavours to walk along the outcrop, or as nearly along it as the jungle permits. It is most unlikely that he will find any actual exposures of the beds to define the boundary line but the sandstone scarp will probably be recognisable, although the precise position of the base will be unknown. The geologist will keep track of his position on the map by some very rough method such as hand compass and pacing or even estimation of both direction and distance (Figure 8). He may cross several small streams whose exposures will be compared with the original section and will serve as a check on the position of the boundary. After following up the bed for some distance, another traversed stream may be reached or there may be a path or cross-country traverse. The rough traverse is then 'closed' to one of the numbered pegs and the necessary correction shown on the map.

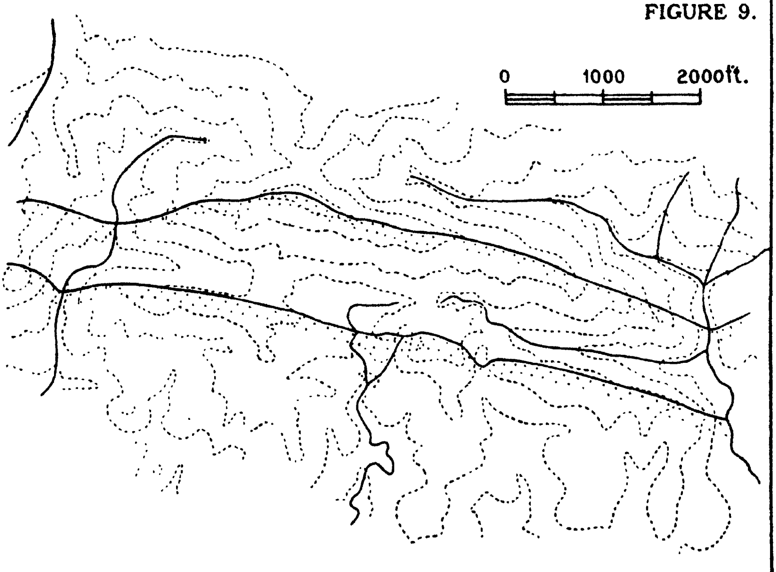
49. Some of the stronger beds will form watersheds, and if these have been traversed, sketching in the trend of the

FIGURE 8.



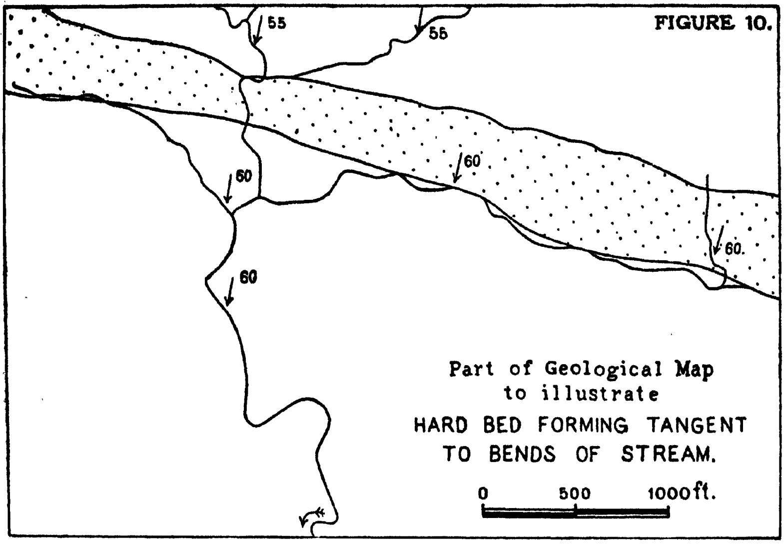
Part of Field Sheet
To illustrate use of rough traverse to fix position of mapped bed between stream sections.

FIGURE 9.



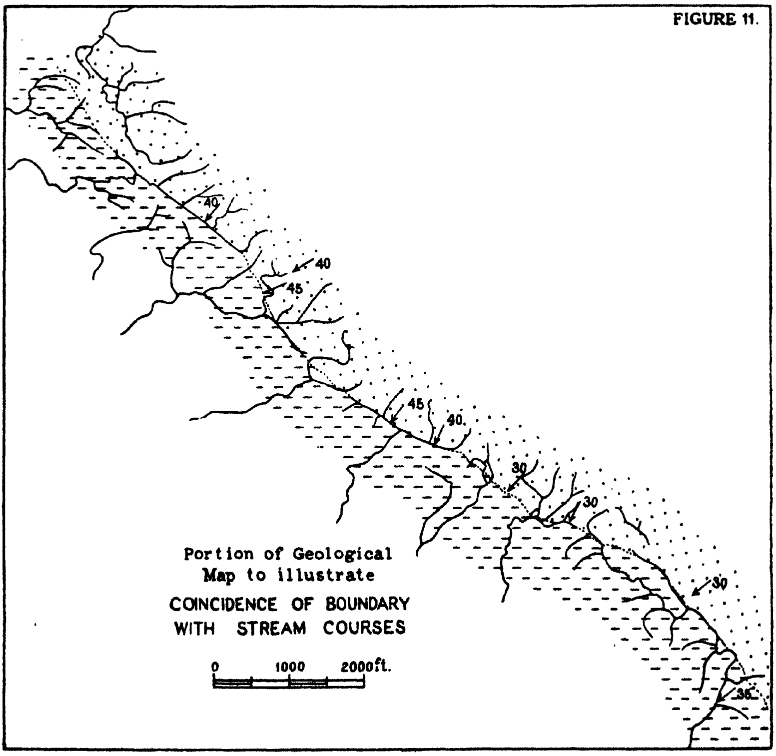
Portion of Geological Map
to illustrate
COINCIDENCE OF HARD BEDS AND RIDGES,
enabling beds to be followed
even in the absence of exposures.

FIGURE 10.



Part of Geological Map
to illustrate
HARD BED FORMING TANGENT
TO BENDS OF STREAM.

FIGURE 11.



Portion of Geological
Map to illustrate
COINCIDENCE OF BOUNDARY
WITH STREAM COURSES

bed between small streams will be a simple matter if the feature is sufficiently pronounced (Figure 9). In other instances, a main stream may follow a soft bed for a long distance, a hard bed being almost tangential to the meanders (Figure 10); the geologist then goes up the main stream and examines each small tributary stream in turn, pacing or estimating distances, and so fixing his boundary line at very close intervals, and taking advantage of whatever features he may find to sketch in the trend of the boundary between the tributaries. Mapping is very greatly facilitated where a stream follows an actual boundary. In some instances strike streams have been found to follow a boundary within a few feet for distances of several hundred feet at a time (Figure 11).

50. Throughout the mapping, the geologist must be constantly on the look-out for the trend of features; he must think of the topography in terms of strike ridges, dip slopes, scarp faces and strike valleys even though he only rarely gets a clear view of the surrounding country. Unless the relief is very low, much assistance is gained by the constant use of an aneroid barometer. The aneroid heights must be recorded in a notebook and, after correction, entered on the map in a distinctive ink, blue being very convenient. The aneroid results may very well be supplemented by rough formlines to show the main ridges; these should make no pretence to great accuracy (Figure 12).

51. A brief digression is perhaps desirable here as the text-books seldom explain the use of the aneroid. In tropical or sub-tropical countries there is generally a diurnal variation; in Assam, during the cold season, this amounts to 100 or 150 feet of indicated height (Figure 13). This can be fairly well allowed for by a second aneroid in camp, provided there is another observer available, and more roughly if there are enough readings to establish the usual nature of the variation. There is also a calibration error which varies from day to day. All errors can be allowed for if there are in the area a sufficient number of known spot-heights, either from previous surveys or specially determined by some method of levelling. Duplicated 'out and home' aneroid 'traverses' controlled by these primary spot-heights can by careful arrangement be made to give results almost free from errors of diurnal variation or calibration, so establishing a series of secondary spot-heights by which the aneroid is checked whenever opportunity occurs. Points such as important stream junctions likely to be revisited in the course of a day's mapping provide convenient check points enabling the errors due to diurnal variation, change of calibration or movement of zero owing to jars, to be very greatly reduced.

52. The form-lines controlled by aneroid heights help to take the place of the panoramic view that may be so extremely

useful in more open country and they are also a great aid to section drawing. There should not, as a rule, be any attempt to turn them into contours or even to try to complete them for the whole area; they should in general be restricted to the delineation of the main ridges and spurs, and to any areas where extra precision is necessary. The aneroid heights also will be mainly on ridges or in streams.

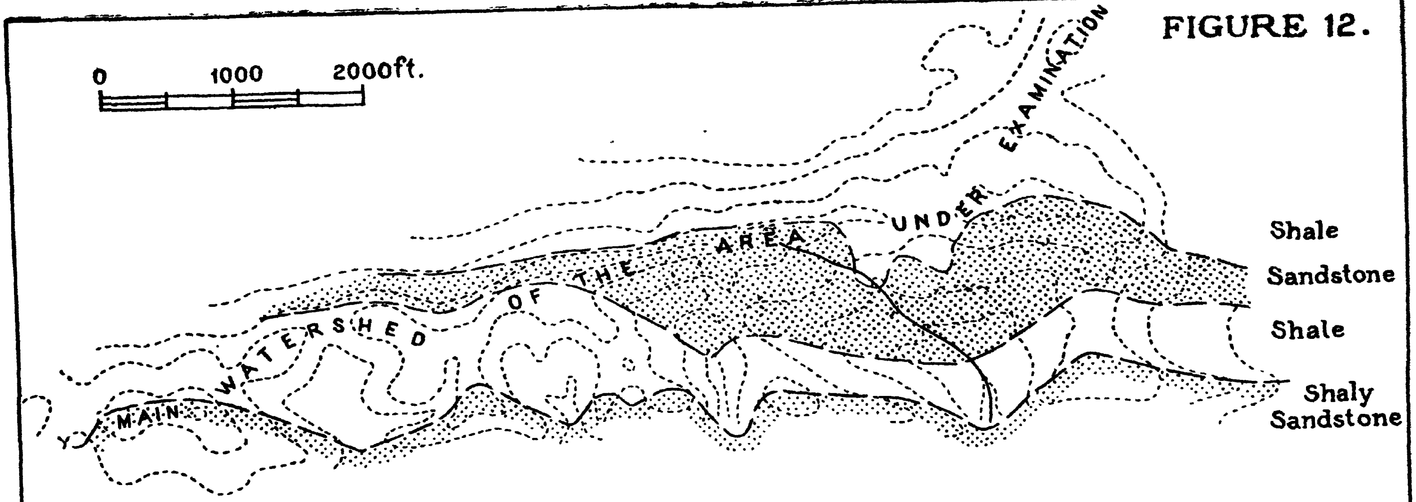
53. If the relief is very low, there may be a network of small streams providing but poor exposures of the beds. If, too, the jungle is very thick, the geologist will be almost restricted to the streams and watersheds. Where exposures are poor, the hammer may be less useful than a hoe; a very careful look-out is kept for fragments of rock in the banks of the streams and by free use of the hoe or of some form of auger a boundary line can often be dug out. Great care must be taken in applying the evidence from a digging; debris of tough clay or shale, hard sandstone and limestone can travel a very considerable distance down-hill and it is easy to confuse travelled rock fragments and those derived from underlying beds. Even accumulations of sandstone boulders may not indicate the presence of a sandstone bed; they may be chance aggregations brought about by quite accidental blockage of streams. Small springs, mud-wallows, marshy places, changes in vegetation, changes in the slope of a stream or in the breadth of its valley may all indicate some geological change and give a clue to the trend of a boundary line. These points are of course well known to the geologist working in more open country but in thick forest their importance is greatly enhanced, and the geological surveyor should form the habit of trying to find an explanation for every natural feature.

D. *Points of Special Difficulty.*

54. Many of the usual difficulties associated with geological mapping are necessarily greatly accentuated by the impossibility of obtaining anything approaching a clear view of the country which is being mapped. Reference has already been made to the assistance which can be obtained from aneroid readings, form-lines and other means of indicating on the map the general relief of the country under examination. Whatever use is made of these aids, much must necessarily depend on the ability of the geologist to visualize the three-dimensional appearance not only of the country itself but also of the underlying rocks. No doubt much can be done by constant practice with maps of various types but it is a definite advantage for the geologist engaged in mapping in jungle-covered country to have a well-developed power of visualizing the unseen topography and structure.

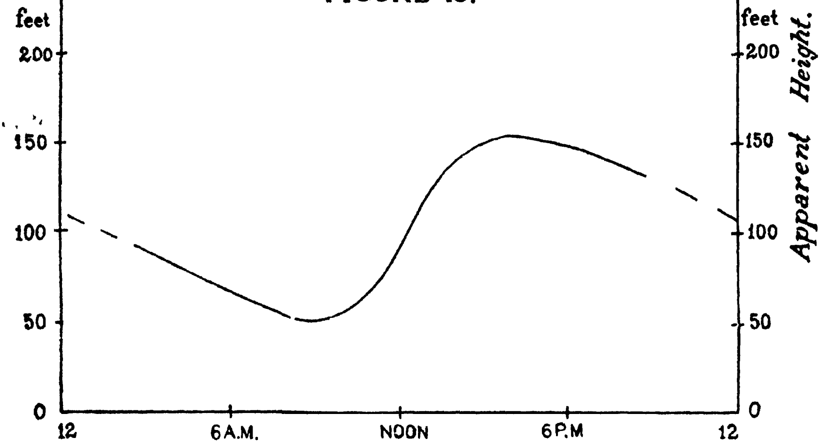
55. Reference may be made to a few of the difficulties

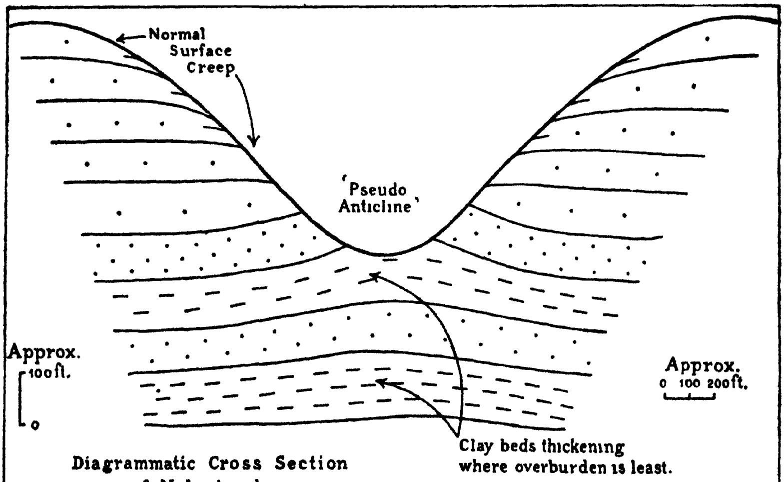
FIGURE 12.



Portion of Geological Map to show
ROUGH FORM LINES based on a few aneroid heights
and occasional views and Abney level readings
obtained from chance clearings
These enabled outcrops of the more outlying beds
to be sketched in with sufficient accuracy

CHART SHOWING NATURE OF DIURNAL CHANGE IN ANEROID READINGS.
FIGURE 13.





Diagrammatic Cross Section of Nala to show
CONTRASTED EFFECTS OF SURFACE CREEP AND LOCAL UPLIFT ALONG VALLEY BOTTOMS.

FIGURE 14.

which are more especially noticeable in working in the conditions under consideration.

56. It is invariably very much easier to trace the feature formed by a hard bed when one is going up-hill out of a small stream than when going down-hill into a stream and it may even be necessary in doubtful cases to retrace one's footsteps back up the hillside to ascertain whether or not the bed has been correctly followed. This difficulty is very slight when dips approximate very nearly to the vertical or horizontal but may cause much trouble with beds dipping at about 30 or 40 degrees.

57. Another difficulty in densely forested country is particularly noticeable when dealing with crestal portions of an anticline. The dip may be low and may change both in amount and direction somewhat unexpectedly. Beds which have been mapped a short distance down the flank may reappear as outliers on hill tops in the crestal area; no streams expose these outliers and their identification may rest entirely on the presence of small fragments occurring on the tops of the hills, possibly revealed only by digging shallow holes. The difficulties associated with very low dips will be greatly accentuated, if, as in the case of the Assam Tertiaries, there is much lateral variation. The rapid thickening and thinning of individual beds may lead to very erroneous resûlts if the outcrop is sketched in in accordance with the contours and measured dips without checking its actual course in whatever way may be possible.

58. Another source of difficulty is the occurrence of dip-faults. Where the nature of the ground makes it difficult to trace beds from stream to stream, the succession in one hill-side stream may appear very different from the succession in an adjacent stream due entirely to the lateral variation of the rocks. The failure to find comparable successions in two adjacent streams may lead to the erroneous supposition that dip-faulting occurs. On the other hand, dip-faults may bring together beds of different ages but of much the same lithological characters so that the fault goes unrecognized. The chances of this happening will be considerably reduced if several sub-groups are mapped, particularly if these have differing thicknesses. Whenever a dip-fault is suspected it is desirable to take steps to obtain as much additional evidence as possible along the supposed course of the fault; for example, a traverser can be sent out to cut and survey a track roughly along this line, the geologist subsequently making a close examination of the ground on each side.

59. Strike-faults are very difficult to detect in preliminary reconnaissance work but, unless they are of very small throw, they should be easily found during detailed mapping provided the general structure is not of great complexity. In

the Tertiary areas of Assam, strike-faults, often of very great magnitude, are very common. Their recognition in the field is often a very simple matter where there is visible anticlinal folding, the strike-faults in many cases replacing the middle limb of an anticline. In some other instances very little disturbance occurs along a strike-fault, there may be no abrupt change in dip and beds of like nature may be brought together; in such cases the recognition of the fault must depend very largely on the geologist's knowledge of the details of the succession; possibly the field mapping can subsequently be confirmed by micro-petrological investigation. The smaller strike-faults may be recognizable by anomalous topographical features; for example, in one area in which I was mapping there was an easily traceable group of sandstones forming part of a scarp and providing a convenient datum line from which to measure the stratigraphical thickness of the beds above and below. Some distance above these beds there occurred a very soft argillaceous group, still higher up a hard calcareous-argillaceous-arenaceous group. The highest point in the area was formed by beds which appeared to occupy the place assigned to the very soft argillaceous beds and it was by no means clear how such soft beds could give rise to so big a feature. Further search showed signs of disturbance and it was eventually found that a small over-thrust strike-fault cut out the soft argillaceous beds and brought into their place in the succession the very much harder but also partly argillaceous, overlying beds, so forming the high point.

60. Much care must be taken in recording dip evidence. In country of the type under discussion dips are entirely confined to the stream exposures and even here great care is necessary to make certain that the dips are representative. False dips, influenced by surface creep, can be found in very shallow *nalas* on steep slopes as well as in the banks of deeper *nalas*. The most reliable dips occur in the bed of the stream itself although their measurement may not be especially easy. Where nearly horizontal alternating beds of clay and sandstone occur in deeply dissected country it is often found that the dips in a stream have an anticlinal habit suggestive of the coincidence of a minor anticlinal axis with the stream course; in isolated instances, this may be mistaken for true anticlinal structure but careful examination will show that the supposed anticlinal axis follows the windings of the stream and is a purely surface feature depending on the removal of the overlying rock from the stream valley (Figure 14). It will be noticed that the tendency to give dips directly into the hill-side is in opposition to the effects of surface creep (often known as terminal curvature) which tends to give dips down hill. Cases have been noticed where false dips occur over a very large area, the dip being almost always parallel to the

general slope of the hill-side and the explanation appeared to be that a limestone occurring only a short distance beneath the surface had suffered much from solution, and the surface features had very largely been determined by the effects of the removal of the limestone.

61. The numerous difficulties referred to in the preceding sections may appear a somewhat formidable list but in practice it will be found that persistence and patience will lead to a resolution of many of the perplexities, or at least to the reduction of the number of possible explanations to a very few whose merits can be carefully compared. If during the early stages of mapping a number of difficulties crop up it may be best to disregard the advice given to keep the mapping compact and leave the difficult area to be re-visited when more experience of the ground has been acquired. Occasionally the difficulties can be satisfactorily overcome by making use of a much larger scale for the mapping of a small part of the area. Help is most likely to be forthcoming by combining a larger scale with a few well-planned excavations. Where the area is of somewhat low relief a large number of excavations may be necessary. This was found to be the case in detailed mapping in Trinidad, but in areas where the relief is moderately high, as in most of Assam, the need for excavations is considerably reduced and excavating on a large scale will be restricted to a few isolated spots where critical evidence is desired. This remark does not of course apply to the frequent use of the hoe or possibly pick in the sides of small streams without which exact evidence of boundaries may be impossible.

E. *Completing the Map.*

62. It is hardly necessary to devote more than a few words to a discussion of the completion of the map since this is a subject covered by many text-books. The field sheets (Figure 15) should, if possible, be ready for reproduction by whatever method is to be used. They should not need extensive re-drawing. It is a convenience to have all geological details in black, all streams and heights in blue and paths, ridges, buildings and survey points in red. Other colours can be made use of if necessary, for example, green for the boundary lines of properties. My own preference in completing a coloured map is to avoid applying crayons for lithology and to use them sparingly or not at all for colouring in the group boundaries. As soon as each field sheet is completed the groups are coloured with ordinary draughtsman's watercolours using a very light wash so that no details are obscured. This method is not always practicable and it may be desirable to colour boundaries in the field as the mapping proceeds, using coloured crayons. It is important to record as much of the evidence as possible

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65. Rudra, Esq., c/o Messrs. M. A. T. Acharya and Co., Bangalore City.
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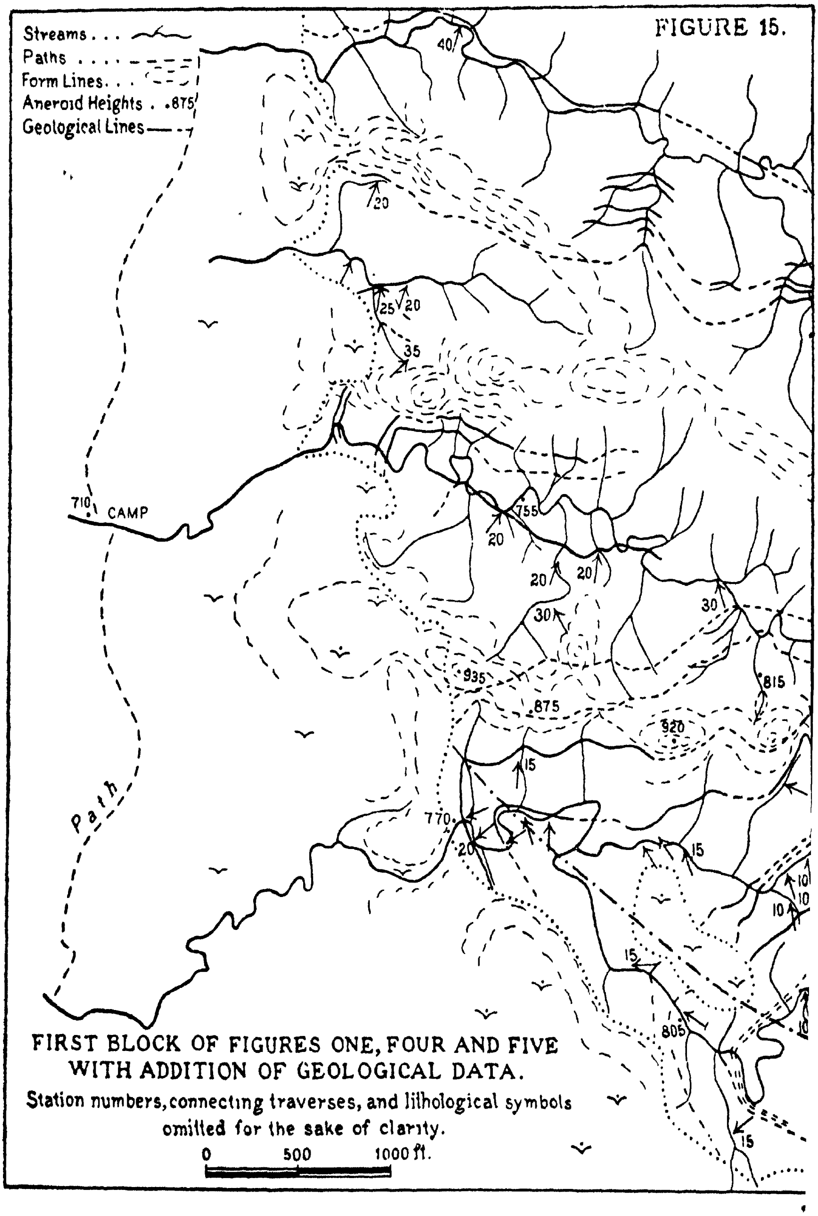
on the field sheet during the actual survey, restricting the use of the note book to aneroid heights, traverse figures and details of special sections.



63. It is desirable to get these field sheet data inked up each day, but this rule cannot be rigorously applied; in jungle-covered country the geologist will probably be dependent entirely on walking and if his camp is necessarily situated at some distance from his work much time may be spent in going to and from work. If so, it is a saving of time to get in as long a day as possible when working in the more distant parts of the area, even at the expense of leaving the inking up to be done the following day. A word of caution is necessary here since there may be a temptation towards the end of the day to continue mapping longer than is really justified. After a long day in the field one begins to get careless and unobservant and too great a prolongation of the day's work will undoubtedly lead to errors. The geologist should therefore resolutely close his map-case and stop work as soon as he finds himself becoming unobservant.

64. In preparing the final map care must be taken to show topographical details as otherwise anyone going over the ground later on may find it very difficult to identify his position. On the other hand, a map crowded with topographical features may fail to show the essential geology with sufficient clarity. This error is more likely to be found in maps of populous areas than in maps of thickly forested, sparingly inhabited country.

IV. Mapping on Smaller Scales.

65. Although the small-scale mapping should logically precede the more detailed work, it is convenient to reverse the order for purposes of discussion. Very much the same types of methods are used in mapping on, for example, the one-inch scale, although here no attempt will be made to attain the accuracy of topography desirable in the more detailed work; usually it will be sufficient to make use of whatever published maps are available, to enlarge these to the required scale, and add such supplementary details as may be found necessary. Much will depend on the accuracy of the maps available but it is seldom possible to dispense entirely with traversing as very few maps of jungle-covered country give sufficient details to enable one to identify one's position excepting at points such as important stream junctions, isolated peaks, etc.

66. Rigorous tape and compass traverses will usually be restricted to those streams likely to give good sections suitable for exact measurements of the succession. Elsewhere the geologist will dispense with the assistance of a traverser and keep his position by means of pacing and hand-compass traverses or by some even rougher methods of keeping track, of which a few may be worth mentioning. Even more than in the case of detailed work, the geologist is dependent on the

streams, and he is, therefore, mostly concerned with means of keeping track in the streams. Where the available map is thought to be reasonably good the most satisfactory method of keeping position is to note on the map the exact time at which each stream junction is reached. Except in the case of very large streams or small rivers the bends are likely to be too generalized to be of any great assistance, although in exceptionally accurate maps the more important bends may be recognizable even in small streams. The actual geological observations are entered in the note book, which is used much more than in detailed mapping, and the exact time of each observation noted. Provided the identifiable points are sufficiently near together, this method gives a convenient means of getting all the geology on to the map but it may be necessary also to take some account of the variations in rate of progress in the different parts of the streams between identifiable points.

67. Where the best available map is less satisfactory, it is convenient to resort to a time and compass traverse. The geologist should be able to estimate his rate of travel under various conditions. It may be two to three miles an hour in a dry stream with a firm sandy bottom or less than half a mile an hour in rocky, boulder-strewn mountain torrents. At each stream bend a compass observation is taken and the time noted together with some indication of the prevailing rate of progress. An allowance is made for time taken up in geological observations. This may sound somewhat complicated but in actual practice is very simple and provides a convenient means of plotting out the course of a *nala* of which only a generalized version is available on the existing map. An even rougher method is to take the direction from the sun. This is possibly of little use in stream traversing but may be extremely helpful when going along a path not shown on the map or shown only very roughly. Where this method is used the direction of the sun (or preferably of one's own shadow) is checked from time to time with the compass. If the sun is behind, it is easy to estimate the general direction of travel by keeping a look out for the angle between one's shadow and the direction of the path. The direction of travel is naturally only recorded from time to time and not at each bend in the path. If the sun is in front or approximately at right angles to the general line of march, it is best to have a man walking a couple of yards ahead to provide the shadow. On a path the rate of travel may be rather more variable than in a stream—a gentle descent on a good path may add almost a mile an hour to one's speed without it being appreciated. For traverses along a path it is therefore preferable to use a pacing counter; this is an extremely simple counting

mechanism which is held in the left hand and pressed as each alternate step is taken. After a very little practice this becomes so nearly automatic as to cause no inconvenience whatever and traverses of 10 to 15 miles can be carried out in this manner with extremely little trouble and with a much greater accuracy than by any method based solely on time. A long pacing traverse based on actual counting is undesirable since the effort of counting necessarily detracts from the concentration on geological work besides being somewhat liable to error and tending to fatigue. Direction may be by compass or sun.

68. Time traverses are particularly applicable to journeys by boat but may also be applied to travel by ponies, elephants, etc. Where possible, time traverses of whatever kind should be 'closed' to a known point, or, if opportunity occurs, they should be checked by taking compass bearings on to three known points.

V. Cost of Geological Survey in Jungle Country.

69. It will readily be appreciated that, compared with work in open country, geological surveying in densely-forested tracts is extremely slow and expensive. Travel is both slower and more costly; the radius of action from any given camp or other head-quarters is much less, men must be employed to cut through the jungle, adding to the expense, not only directly in wages but also, in many cases, indirectly in the cost of transport of rations, tents, etc. There is, therefore, little inducement for the private worker to attempt the solution of geological problems involving mapping of any kind in country which is heavily wooded. Even with official surveys this drawback is still a considerable handicap. In the case of companies or individuals engaged in developing the economic resources of a large forested area, the total outlay is of necessity very large and although geological mapping is in itself a very costly item it forms only a small proportion of the total expenditure involved.

70. Although the actual cost of geological work must vary very greatly according to the accessibility or remoteness of the area examined, local rates of wages, the complexity of structure and stratigraphy, and many other factors, it would seem to be of interest to quote a few actual figures giving an idea of the magnitudes involved. Unfortunately I have not been able to trace any published figures relating to the cost of geological surveys in jungle country, and it may be doubted if any even approximately comparable figures have ever been made available.

71. In the absence of any published data, the Burmah Oil Company have kindly allowed me to make use of figures

based on work in Assam. From these it appears that the total cost of examining a single anticlinal area varying from, say, five to fifteen miles in length and one or two miles in breadth may vary between Rs. 10,000 and Rs. 30,000. On an area basis taking the total area examined (which may include a certain extent of outlying country examined in much less detail) the cost may be between Rs. 1,000 and Rs. 5,000 per square mile. The size of these estimates may be surprising but, as already indicated, they can only be correctly judged when seen in proper perspective by comparison with the total cost of prospecting work. Here again comparable figures are not readily ascertainable, but to take as an example the work with which I have been connected—that of prospecting for oil, the cost associated with the early stages of development of an area may conveniently be divided as follows:—

(*a*) Share in the cost of small-scale mapping.
(*b*) Cost of detailed mapping.
(*c*) Concession fees.
(*d*) Cost of drilling one or more test wells to find out whether oil is or is not present in commercial quantities.

Of these items, the last mentioned, including as it does, the cost of building roads and possibly railway track, the purchase of machinery and fuel, the transport of materials of all descriptions to the site, erection of houses and the payment of wages, is by far the most expensive. For example, an area recently tested in Upper Assam (with negative results) involved a total outlay of Rs. 16 lakhs of which the original geological work cost about Rs. 20,000. Expenditure in three areas in the Surma Valley on which prospecting operations have been in progress for a number of years without, so far, reaching any definite result has already exceeded 180 lakhs. The original geological work in connection with these areas cost about half a lakh. These figures show that, expensive though geological mapping must necessarily be in difficult jungle-covered territory, it forms only a small part of the very great outlay involved in adequate prospecting operations.

72. From another point of view, bearing in mind the very large sums involved in a recommendation to drill a deep test well or to sink a mine shaft, it is very clear how important it must be for the geological work to be carefully carried out; the difficulties of the territory must not be allowed to detract from the reliability of the geological work as a result of which such large sums may be expended. Even with the greatest care, there remains in many prospecting operations, and especially

in the petroleum industry, a very great gap between the best available geological work and the actual proving of economically workable accumulations of minerals. For example, the Burmah Oil Company alone have spent during the past twenty years over three crores of rupees[1] in prospecting operations, all based on geological advice, without unfortunately receiving any return whatever, or as yet proving the existence of even one new commercially workable oilfield. Such a figure illustrates not only the very great cost of prospecting in 'jungly' country, but also the necessity for the geologist to be continually on the look-out for ways and means of perfecting the application of his science to the problems of the development of the economic resources of the country. The preceding remarks have been prepared with the hope that it would be of some value to place on record one of the many lines of development by which geologists have been attempting to reduce the uncertainties of the application of geology to industry, and in conclusion I have to express my indebtedness to the Burmah Oil Company for permission to publish methods used in their work and to my colleagues on the Company's geological staff whose experience has been freely drawn upon.

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[1] Approximately Rs. 3,60,00,000.

Section of Geology.

Abstracts.

MINERALOGY.

1. On the mode of occurrence and origin of Cummingtonite in the limestones of the Kudurekanive Range of Hills, Tumkur District (Mysore State).

B. BALAJI RAO *and* B. RAMA RAO, Bangalore.

The clove brown mineral conspicuously occurring in some of the limestone outcrops of the Kudurekanive range of hills, near Huliyar (13° 35′ : 76° 33′), has been identified by its physical and optical characters and by its chemical composition to be a variety of Cummingtonite. The presence of a ferruginous amphibole as a secondary mineral in a highly calciferous limestone being unusual, its mode of occurrence was studied in the field and this has disclosed that the mineral has been formed as a result of metamorphism in the portions of the limestone where it is interlaced with bands of ferruginous quartz schist. It is evident that the requisite amounts of iron and silica for the crystallisation of Cummingtonite in the limestone matrix, have been contributed by the ferruginous quartz schist. The question whether the latter rock has found its place in the limestone as a set of intrusive veins or as veins of replacement by circulating solutions has been briefly touched upon. Though the evidence is neither definite nor conclusive, yet it seems to indicate the probable igneous mode of origin of the ferruginous veins.

2. A note on the constitution of Cummingtonite.

E. R. TIRUMALACHAR *and* M. B. RAMACHANDRA RAO, Bangalore.

A study of the chemical analyses of Cummingtonite from several localities has shown that there is an excess of silica over the metasilicate ratio in each case. In many of the samples there is water, sometimes running up to as high as 3 per cent. and it is shown that this water is not likely to be constitutional but only held in solid solution. The constitution of Cummingtonite is then explained as a mixture of ortho- and poly-silicates of iron and magnesium, and the differences in the proportions of FeO and MgO explain the apparent excess of silica over the metasilicate ratio.

3. On the zoned felspars from the Porphyries near Mysore.

S. R. NARAYANA RAO *and* B. S. BHIMA RAO, Bangalore.

The paper records certain observations made regarding the exact nature and constitution of the zonary banding noticed in some of the felspar phenocrysts from the porphyries near Mysore. Attention is drawn to the variations in the composition of the different zones—as indicated by micro-chemical methods. Some peculiarities relating to the mode of alteration of these zoned felspars are pointed out and their significance discussed.

4. A study in the uralitisation of Hornblende.

K. Sripada Rao *and* M. B. Ramachandra Rao,
Bangalore.

While the nature of the uralitisation of pyroxenes is fairly well known, there has been little or no information regarding the transformation of amphiboles into Uralite. The present paper serves to throw some light on this problem and is a study in the uralitisation of Hornblende—from an amphibolite found near Sakarsanhalli (12° 47′: 78° 13′), Kolar District. From a detailed study of the Uralite in relation to the Hornblende and comparison with the similar alteration product known to be associated with pyroxenes, it is shown that the probable causes for, and processes involved in, this type of mineral alteration are essentially similar in the two cases.

5. Ilmenite crystals from Kishengarh State (26½° : 75°), Rajputana.

S. L. Biswas *and* B. Maitra, Calcutta.

The crystals show distinct cleavage parallel to the basal pinacoid. Forms developed are c, s, r, n, a, e, n_1, ζ, m, (Dana) and also the new forms ζ_1 $(22\bar{0}5)$, $q(055\bar{4})$, and $\rho(404\bar{5})$.

A stereographic projection of the different forms is given.

6. A short note on the habit and the alteration of Magnetite.

S. Lakshmana Rao, Bangalore.

The mineral described in the paper is found in the highly altered ultrabasic rock, near Talur Chrome Mines (12° 11′ : 76° 37′), Mysore District. It is isometric in crystal system and occurs in cubes and combination of cubes and octahedrons. The development of new faces due to corrosions has been just noted. Spinel type of twinning as well as oscillatory combinations, the latter, in microsections, have been noticed. The mineral has dark brown colour, submetallic lustre with a brownish tarnish, and reddish brown streak. Its hardness is 5–5·5 and Sp. Gr. 4·23. The chemical composition of the non-magnetic portion is Fe_2O_3 84·83%; Cr_2O_3 0·48%; SiO_2 4·15%; Al_2O_3 0·10% and MgO in traces, H_2O 7·92% and its formula is 5 Fe_2O_3. 4 H_2O. Its habit and its angular measurements suggest the mineral to be magnetite, but its chemical composition, streak and low specific gravity and non-magnetic property confirm the mineral to be a pseudomorph of hydrous ferric oxide having the formula 5 Fe_2O_3. 4 H_2O.

7. On the secondary pyroxenes and associated minerals from the Tarurites of the Sakarsanhalli Area, Kolar District (Mysore State).

K. Sripada Rao *and* M. B. Ramachandra Rao,
Bangalore.

The paper deals with a detailed study of the Tarurites from the Sakarsanhalli area (12° 47′: 78° 13′), Kolar District, especially with a view to investigate the nature of the secondary pyroxenes and associated minerals contained therein. On the basis of their optical characters and chemical constitution, it has been shown that the so-called 'Secondary Augites' of this rock are really of the nature of Diopside.

Attention is drawn to the occurrence, associated with these secondary pyroxenes, of Rhodonite, Spessartite and Scapolite, and the interesting question of the exact mode of origin of these minerals in this area is next discussed. Apart from these, a few minerals allied to Blanfordite or Piedmontite and Winchite are tentatively identified in some of the sections.

8. An alternative formula for the mineral Vredenburgite.

M. R. ANANTANARAYANA IYER, Bangalore.

In view of the fact that Vredenburgite is strongly magnetic and that other strongly magnetic minerals belong mostly to the spinel group, the analytical figures for the two specimens of the mineral given in Dr. Fermor's Manganese Memoir are recast so as to give a spinel grouping in the formula. The formula suggested for the mineral is obtained by recasting the analyses of two specimens given in the above Memoir and three new analyses by the author; it is a combination of the formulæ for Bixbyite and Spinel. It is suggested that Sitaparite may be classed under this group as a distinct species.

In discussion, Dr. Fermor pointed out that recent work by Dr. Christie suggests that Vredenburgite is a mixture of two manganese minerals.

ORES.

9. Chromite deposits in Mysore.

T. P. KRISHNACHAR, Bangalore.

In Mysore, chromite deposits are practically confined to ultrabasic members of Dharwar system. Lens-shaped ore-bodies in Hassan District lie along Nuggihalli schist-belt (13° 1′: 76° 28′), in talc-serpentine matrix, while near Mysore chromite veins occur in altered dunite rocks. These ultrabasic rocks are intrusive into original hornblende-schist and are intruded by later gneisses.

Surface and underground observations do not favour the suggestions made regarding the altered dunite rock being a peridotite member in the basic division of charnockites.

Serpentine and Magnesite have been formed by the alteration of Olivine (in Mysore District) and Enstatite (in Hassan District) through the agency of water charged with carbon dioxide.

From the cooling ultrabasic magma, Chromite was separated out as the first basic differentiate and the degree of concentration (i.e., segregation) varies from the pure aggregate of a lens to the ultrabasic rock with some grains of Chromite.

High-grade ore deposits of Hassan District are being worked by open quarrying, and those near Mysore by underground methods. Near Arsikere (13° 19′: 76° 15′) a concentration plant is now set up to concentrate the low-grade ores. Some experiments are being conducted by the Mysore Government to produce ferrochrome from the high-grade ores of the state.

10. Microscopic characters of Bawdwin Ores.

S. K. ROY *and* S. KRISHNASWAMY, Dhanbad.

The authors made a systematic study of the polished specimens of Bawdwin (23° 7′: 97° 19′) ores collected by one of them and during their investigations discovered Tetrahedrite, Bornite, Proustite, Pyrrhotite, etc., not reported from this area before.

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78. Dr. W. C. Sweet, B.Sc., M.D., Dr.P.H., Rockfeller Foundation Consultant in Health, 'Grace Villa', Palace Road, Bangalore.
79. Rao Bahadur B. Venkatesachar, M.A., Central College, Bangalore.
80. A. Venkat Rao Telang, Esq., M.A., Central College, Bangalore.
81. Dr. H. E. Watson, D.Sc., F.I.C., Indian Institute of Science, Bangalore.
82. Dr. S. Ramaswamy, B.Sc., Ph.D., Visveswarapuram, Bangalore City.
83. H. V. Krishnayya, Esq., B.A., F.C.S., Deputy Director of Agriculture, Bangalore.
84. M. J. Narasimhan, Esq., B.A., Offg. Mycologist, Department of Agriculture, Bangalore.
85. T. B. Subramaniam, Esq., Acting Entomologist, Department of Agriculture, Bangalore.
86. H. C. Javaraya, Esq., L.Ag., F.L.S., F.R.M.S., Superintendent, Government Gardens, Lal Bagh, Bangalore.
87. V. K. Badami, Esq., L.Ag., Ph.D. (Cantab.), Economic Botanist, Agricultural Department, Bangalore.
88. M. Ramachandra Rao, Esq., B.A., B.L., Judge, High Court, Bangalore.
89. Dr. N. A. Iyengar, Victoria Hospital, Bangalore.
90. M. Ramachandra Rao, Esq., 19. V, Main Road, Chamarajpet, Bangalore City.
91. Dr. T. Balakrishna Moodaliar, Victoria Hospital, Bangalore City.
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93. Dr. B. Sanjeeva Rao, Indian Institute of Science, Bangalore.
94. V. Ramalingam, Esq., No. 2, Lal Bagh Road, Bangalore.
95. B. Sreenivasa Iyengar, Esq., Printers, 3-34, Manavarthapet, Bangalore City.
96. Dr. K. Sreenivasacharya, M.B.B.S., Resident Medical Officer, Victoria Hospital, Bangalore City.

This paper also includes a hitherto unpublished detailed geological map of the mining area on the scale 1"=400 ft. The authors have reclassified the Bawdwin volcanic series into

(i) Bawdwin tuffs
(ii) Teddy grits
(iii) Chloritoid schist
(iv) Rhyolites

and described their micro-characters fully.

11. Note on the kaolin deposit of Manjhapara (Gangpur State, Bihar and Orissa).

D. P. CHANDOKE, Calcutta.

Kaolin is derived by the alteration of a pegmatitic boss, intrusive into Dharwar phyllites at Manjhapara (22° 2' : 84° 12'). The pegmatite possesses large weathered zones of Felspar, with occasional segregations of Rubellite, and a black variety of Tourmaline.

Kaolin is especially rich in alumina, and the percentages of iron and moisture are low. The results of analysis are compared with those for consignments received in India from Cornwall, and also those prepared at the Kasimbazar Mines. The Manjhapara product possesses low plasticity and crumbles away at 1400°C., without showing any coloration. The deposit seems to be fairly extensive.

IGNEOUS ROCKS.

12. A preliminary note on Khanapur Gneiss.

K. V. KELKAR, Poona.

A massive granitoid type of gneiss occurs around Khanapur (15° 38' : 74° 31'), Dt. Belgaum (Bombay). It consists of Orthoclase, Quartz, Biotite, and a subordinate amount of Oligoclase, Microcline and Muscovite. Porphyroblasts of Felspar, chiefly Orthoclase, are embedded in a matrix of granular Felspar and Quartz and Mica flakes. The gneissic structure is usually well developed. In thin sections are observed Apatite, Zircon, Magnetic iron ore, Epidote, Zoisite and granules of Sphene. The gneiss exhibits resemblances to the Bundelkhand type of gneisses.

13. Geology of Pallavaram Hill: the type area of the Charnockite series.

T. N. MUTHUSWAMY *and* C. MAHADEVAN, Madras.

The type area of Charnockite series, i.e., Pallavaram Hill (13° 0': 80° 12'), was geologically mapped in detail (Scale 1"=250 ft.). Besides noting the contact relations and transitions in the members of the series from leptynites to acid, intermediate and basic varieties, a special study of the basic veins and dykes was also made. Petrological examination of over eighty field specimens representing the gradations discloses various stages of differentiation of the original magma. Structural and paramorphic changes in the minerals as observed under the microscope are also described and discussed in relation to the geological history of the area.

14. A short note on Sylhet Trap.

P. C. DATTA, Calcutta.

This short note embodies the results obtained from a chemical and physical study of the rocks collected from the neighbourhood of Cherra Punji (25° 17': 91° 44'), Khasi and Jaintia Hills (Assam).

15. On the nature of the spots found in the trap rocks near Lingadahalli, Kadur District (Mysore State).

CHARLES S. PICHAMUTHU, Bangalore.

There has been some difference of opinion on the question of the exact nature and mode of origin of the ovoid and irregular spots and patches frequently noticed in the Trap rocks of the Lingadahalli area (13° 36′ : 75° 51′). This problem has now been investigated, and from a detailed microscopic study of these 'spots' and their relation to the main rock mass, evidence has been put forward to show that these are of the nature of amygdaloidal infillings and not due either to autoclastic phenomena or alteration of phenocrysts.

16. A note on the tuff of Wajrakarur, Anantapur District (Madras).

C. S. PICHAMUTHU *and* S. RAMACHANDRA RAO, Bangalore.

In view of the suggestion frequently made that the tuff of Wajrakarur (15° 2′ : 77° 23′) must be considered as the original matrix for the South Indian diamonds, a detailed study of this rock type was undertaken to find out its exact nature and probable similarity to the well-known diamondiferous Blue Earths of Kimberley. The rock is a typical tuff and often shows fragments of foreign rock such as the pink Gooty granite, hornblende-schist, etc., all cemented together by a glassy matrix which in some places presents a vitro-clastic texture. Under the microscope, sections of the rock show a general glassy matrix with a few crystalline grains here and there, chiefly of Microcline, Plagioclase Felspar and Hornblende. The general nature of the mineral contents and the entire absence of basic minerals like Augite and Olivine, together with the low specific gravity of the rock, suggest a tuff of andesitic composition, quite different from the matrix of the diamonds in the Kimberley mines.

METAMORPHISM.

17. On the origin and correlation of the manganiferous limestone and associated rocks of Sakarsanhalli Area, Kolar District (Mysore State).

M. B. RAMACHANDRA RAO, Bangalore.

A series of metamorphic rocks of the nature of garnetiferous-quartz-pyroxenites (Taruntes), Cummingtonite-schists, ferruginous-quartzites and manganiferous limestones from Sakarsanhalli area (12° 47′ : 78° 13′), Kolar District, have been carefully examined and mapped. From the evidences obtained both in the field and under the microscope, these metamorphic rocks are shown to be the result of acidic intrusions into hornblende-schists and amphibolites. The limestones have proved to be only secondary alterations of the pyroxenic rocks. The once suggested theory of sedimentary origin is shown to be untenable. It is also shown that these rocks are not of pre-Dharwar age but belong to the lower hornblendic division of the Dharwars.

18. Contact metamorphism in limestones of the Mogok Series from the Mogok Stone Tract (23° : 96½°).

A. K. BANERJI, Calcutta.

Two instances of contact metamorphism are discussed. In the first case a Felspar rock is intruded into limestone, coarsely crystalline Albite being the predominant Felspar in the rock. The contact rock consists of Nepheline, Diopside, Calcite, Felspar and Apatite. The genesis of the contact rock is shown to be the result of assimilation, the Nepheline

being formed through desilication of Albite material. In the other case, a pegmatite is in contact with the limestone. At the contact is developed a rock composed of Scapolite, Diopside, Felspar and Calcite. The contact rock is taken to be due to the interaction with the limestone, of magmatic material derived from the pegmatite.

STRATIGRAPHICAL AND GENERAL (OLDER ROCKS).

19. The Palkanmardi conglomerate.

L. S. Krishna Murthy, Hyderabad State.

At and near Palkanmardi (16° 14′ 3″ : 76° 47′ 11″), Deodrug Tehsil, Raichur District (Hyderabad State) near the junction-zone of the Dharwar schists and the peninsular gneisses, some interesting caught-up pebbles of gneisses and schists occur imbedded in an igneous matrix. They are mostly rounded and some of them are elongated. They vary in size from small pebbles to boulders about 1 foot or more in diameter. The paper discusses the geology of the area and the probable origin of the formation. Maps, photographs, micro-sections, and specimens illustrate the paper.

20. The geology of the country around Ghoriajor (22° 3′: 84° 9′) Gangpur State, Bihar and Orissa.

M. S. Krishnan *and* D. P. Chandoke, Calcutta.

The rocks occurring in this area are referable to the Dharwars, and comprise members of the Gondite series, phyllites, mica-schists, crystalline limestones, gneissose granites and pegmatite. The schistose members are highly folded and dip towards the S.E. or E.S.E. at angles varying between 30° and 60°. The phyllites with the associated gondites seem to be the oldest rocks, followed by mica-schists and crystalline limestones. Tourmaline-bearing granite and pegmatite are intrusive into these. The gondites occur along a band about seven miles long and a quarter of a mile wide. They constitute several types in which combinations of the following minerals are present—Quartz, Microcline, Rhodochrosite, Spessartite, Rhodonite, Blanfordite, Winchite, Barite and Manganophyllite. The ores are mainly Braunite and Psilomelane with minor amounts of Pyrolusite.

Between 1909 and 1928 the area produced about 350,000 tons of ore, but the quarries were abandoned as, with increasing depth, underground mining would have become necessary if work were to be continued. The area is being re-explored by a Calcutta firm who were able to raise about 2,000 tons during 1930-31.

21. On the classification and correlation of the Champaner series of the Bariya State, Rewakantha Agency (Central India).

B. Rama Rao, Bangalore.

Noting the salient features of the different groups of rocks of the northern extensions of Blanford's Champaner Series as developed in the Bariya State (23° : 74°), on lithological grounds and stratigraphic superpositions, the series has been classified into (1) The Dhanpur[1] Schists, (2) the Poyelli[2] Limestone, (3) the Baria[3] Quartzites, (4) the Dharia[4] Limestone, and (5) the Rajgad[5] Shales. Of these it is not clear whether the Dhanpur Schists have to be grouped among the Archaean Schists, or as the lowest members of the 'Champaner Series'. The rest

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[1] 22° 38′ : 74° 6′.
[2] 22° 28′ : 73° 43′.
[3] 22° 42′ : 73° 54′.
[4] 22° 27′ : 73° 40′.
[5] 22° 34′ : 73° 39′.

in their general lithological characters and order of superposition show a striking resemblance to the various groups of the Delhi System of Rajputana. The Poyelli Limestone corresponding to the Raialo Series, and the Baria Quartzites, Dharia Limestone and the Rajgad Shales to the Alwar Quartzites, Kushalgarh Limestone and the Ajabgarh Series respectively, indicate that the Champaner Series may in general be correlated with the Raialo Series and the Delhi System of Dr. Heron.

But the Poyelli Limestone members seem to have also their lithological equivalents among the limestones and the acidic schists in association with the Champion gneisses of Mysore, the constituents of the upper division of Dharwars.

It is doubtful whether the higher divisions of the Champaners, like the Baria Quartzites and the Rajgad Shales, have been represented therein or not.

It can only be said at present that the Champaner Series can be correlated with the Delhi System as classified by Dr. Heron in 1917, and also with a *part* of the upper Dharwars of Mysore. The series can neither be correlated with the Aravallis, nor with the whole of the Dharwars as suggested by some geologists.

22. Some studies in the geology of the area west of Banganpalli, Banganpalli State (Madras).

C. S. Pichamuthu *and* M. R. Srinivasa Rao, Bangalore.

The paper gives a detailed account of the geology of the area about 6 miles west of Banganpalli (15° 18′ : 78° 14′), and from certain evidence detailed in the paper, the probable existence of an east-west fault line, almost parallel to the Jurreru river, is suggested.

23. Notes on the geology of Mt. Diamir (26,620 ft.) (Nanga Parbat), North-west Himalaya, Kashmir.

D. N. Wadia, Calcutta.

Nanga Parbat (35° 14′ : 74° 35′), the culminating peak of the Punjab Himalaya, is not a peak on the central axis of the Great Himalaya Range, but it stands out as a solitary eminence to the north of that axis as a mighty spur. It presents stupendous, bare, rocky precipices to the south and south-west, but to the north, the aspect is rather tame, though this flank ascends 22,500 ft. directly from the Indus bed, within barely 17 miles. This slope is concealed under 100 sq. miles of snowfields, drained by four glaciers which descend nearly 8,000 ft. below the snow-line.

Above 15,000 ft. level, the mountain is almost inaccessible to field geologists, the wall-like precipices of the south, rising sheer 13,000 ft. from the Rupal valley and the unrelieved snow-cap on the north, alike forbid approach. For this portion, the enormous stretches of moraines and the fresh, frost-bitten rock-debris continually shed by the avalanches, are the only means of investigation. Below the snow-line, however, the geological structure as well as composition is laid bare in a series of fine exposures, well seen in the naked cliffs facing the Indus and the Astor valleys.

From these, the geology of Nanga Parbat is found to be of great simplicity. It is composed almost entirely of finely schistose, streaky biotite-gneiss with interbedded coarsely re-crystallised marble, graphite-schist, etc., well-stratified and having a persistent dip to the north-west; these are traversed by thick basic black epidioritised dolerite sills and dykes, now represented by massive amphibolite and hornblende-schist. The present writer has no doubt that the biotite-gneiss is a paragneiss, a transformation-product of original pre-Cambrian sediments (his Salkhala

series) which constitutes the country-rock of the surrounding region. Through this basement complex are thrust sheets and dykes of acid granite-gneiss of a later intrusive phase. In the Tarshing valley and further south-east near Rattu, the Nanga Parbat gneiss gradually passes into less metamorphosed Salkhalas in which all the typical elements are easily recognised.

The tectonics of the Nanga Parbat region is discussed in relation to the syntaxial angle of the North-West Himalaya.

STRATIGRAPHICAL AND GENERAL (ARYAN).

24. On the flints and cherts of the Niniyur Stage (II).

L. Rama Rao *and* C. Prasannakumar, Bangalore.

In a paper communicated to this section of the Congress in 1930, the authors have generally established the fact that the several bands of flints and cherts of the Niniyur Stage, are all the result of silicification of previous organic limestones. The present paper is a more intensive study of the flints from a particular area, near Sainthoray (11° 15′: 79° 13′), with a view to resolving them further into definite types based on the exact nature of the parent rock and subsequent differences in the type of silicification.

25. On the mode of origin of the Lameta limestone of Jhabu, Bariya State (Bombay).

B. Rama Rao, Bangalore.

Due to Dr. Fermor's suggestion (*Rec. Geo. Surv. Ind.*, Vol XLIII, page 32) that many of the so-called Lameta Limestone outcrops of Central India might be of metasomatic origin, as he found to be the case of the infra-trappean limestones of the Chhindwara District, the Lameta limestone band of Jhabu (22° 40′ : 74° 11′) was carefully examined. All the evidence available in the region points out that the main mass of the limestone could not have originated due to replacement of any rock by calciferous solutions, either during the pre-trappean or post-trappean period. By its definite horizon underlying the sandstone members of the 'Lameta series' and overlying unconformably the crystalline schists, and by the characteristic micro-textures of the slides of many of its specimens, the rock is believed to have a true sedimentary mode of origin.

In the same region are other insignificant isolated patches of calciferous rocks formed by diverse methods which by their infra-trappean position might be mistaken as variant phases of the true limestone. Instances of such pseudo-Lameta calciferous rocks have been noted for comparison.

26. The application of the Nappe Theory in the Himalayas.

S. K. Roy *and* B. Bhargava, Dhanbad.

When mapping Mandi State (31½° : 77°), Punjab, geologically, one of the authors found slicken-sided masses of pink dolomite marble, probably of Blaini age, lying unconformably in irregular and isolated north-south strips on the unmetamorphosed Tertiaries of the area, at an altitude of about 4,000 ft. The rocks are lying among these without roots. Similar rock is found, more or less at the same altitude in autochthone condition only after one has gone more than 16 miles towards east. No trace of the rocks could be seen in the intervening country occupied by hills of granite, slates and quartzite more than 7,000 ft. high. The only

plausible explanation of the above phenomena is that the dolomite has been everthrust as in the case of Nappes of the Alps.

The paper includes the first geological map of Mandi State (scale 1 inch = 2 miles).

27. A note on the Quilon limestone.

C. S. PICHAMUTHU *and* C. PRASANNAKUMAR, Bangalore.

Though the probable presence of a bed of limestone below the laterite round about Quilon (8° 53′: 76° 36′), Travancore State, was suggested so far back as about 1850, yet none of the subsequent observers were able to get at the rock *in situ* but based their conclusions regarding the nature of what they called the Quilon limestone only on the study of a few stray boulders found round about Quilon. This paper records the rediscovery of this limestone below the carbonaceous beds of the Warkalay formation and its *in situ* occurrence has been proved in an excavation about 8 miles south-east of Quilon. The limestone is highly fossiliferous and two types of corals, several genera of molluscs, some foraminifers and a fossil crab have been recorded, all of which suggest a middle tertiary facies.

SEDIMENTARY PETROLOGY.

28. Petrology of some Barakar sandstones occurring in Gangpur State, Bihar and Orissa.

M. S. KRISHNAN, Calcutta.

Barakar sandstones overlying Dharwarian metamorphic rocks occur in the south-western part of Gangpur State (22°: 84°). They have a low (10° – 20°) southerly or south-westerly dip, and their contact with the metamorphics seems to be one of original sedimentary deposition. They are generally felspathic and contain ferruginous matter, Muscovite and occasional Tourmaline.

Heavy minerals were separated from four specimens collected from near the boundary of the Barakars with the metamorphics. Three of these showed very abundant Tourmaline—over 95 per cent.—and small quantities of Magnetite and Ilmenite, Epidote, Garnet, and Rutile. The fourth specimen was an exceptionally pure sandstone with matrix of white clay. The small amount of heavy minerals obtained from this contained iron ore, Zircon, Rutile, Hornblende, Tourmaline, Actinolite, and traces of Monazite, Kyanite, Staurolite and Garnet.

The source of the sediments seems to be the granitic gneisses and mica-schists occurring to the north and north-east, especially as these are rich in Tourmaline and also contain the other minerals mentioned above.

29. The heavy mineral assemblages of white clay and ochres associated with laterite of Sohawal State (24° 25′: 80° 45′), C.I.

N. L. SHARMA *and* S. PURKAYASTHA, Dhanbad.

The white clay and red and yellow ochres of Sohawal State show almost exactly similar heavy mineral assemblages, characteristic minerals being Kyanite, Staurolite, Rutile, Garnet, Tourmaline, and Zircon. The frequency of all the minerals and descriptions of the more important ones have been given in the paper.

It is interesting that most of these minerals are totally absent in the Upper Rewah and Upper Bhandar sandstone beds underlying the laterite in which the high grade clays occur.

COAL.

30. Action of solvents on some Indian coals. IV.

N. N. CHATTERJEE, Calcutta.

In the paper the author has embodied the result of his study of the action of Pyridine and Chloroform on some Jharia coals. The specimens were obtained from seams Nos. X, XI, XII, XIII, XIV, and XV. All of them are caking coals and in quality they do not differ to a very great extent. The amounts of the alpha, beta and gamma compounds in these coal specimens were determined quantitatively and the analytical results show that the amounts of the pyridine-extract in the different specimens vary within wide limits. In the case of seam No. XIV the amount of pyridine-extract was very small whereas that of seam No. XII came to about 11 per cent. of the coal substance. The percentage of the gamma compound in the coal samples also varies greatly. The relationship between the amounts of these extracts and the carbon-hydrogen ratio is discussed. The effect of oxidation of the coal substance on the caking property and the behaviour of the oxidised coal substance towards the solvent action is also dealt with in the paper.

WATER SUPPLY.

31. Salinity of the underground water and occurrence of Brine in parts of Raichur Do-ab (16° : 77°), Hyderabad State.

S. K. MUKHERJI, Hyderabad State.

Parts of Raichur Do-ab, Hyderabad State, are saliferous. The indigenous salt industry has been carried on from time immemorial both from brine and saline efflorescence. In the course of operations of the Well Sinking Department, it has been noticed that the younger acidic representatives of the Pink Series of Peninsular Gneisses of the area, either in contact with the Dharwar Schists, or independently of them in the neighbourhood, have yielded saline water. The paper discusses the distribution, mode of occurrence and the probable origin of salinity, and gives complete analyses of samples.

PALAEONTOLOGY.

32. On a limestone from the Pondicherry Cretaceous.

L. RAMA RAO, Bangalore.

The paper gives a complete description of a very interesting type of organic limestone, forming one of the members of the Pondicherry Cretaceous and records the extensive occurrence in sections of this limestone, of *Lithothamnion*—an alga which was only recently discovered by the author in the Niniyur beds of the Trichinopoly Cretaceous. From a study of the fossils occurring in this limestone, the question of the probable correlation of the rocks of the Pondicherry area with those of the Trichinopoly Cretaceous, is discussed.

33. Some radiolaria from the Trichinopoly Cretaceous.

L. RAMA RAO, Bangalore.

The paper records the occurrence of Radiolaria from the Trichinopoly Cretaceous rocks and embodies a brief descriptive account of some of the more important types from the phosphatic nodules of Utatur (11° 4′: 78°

35′). Several genera mostly belonging to the Spumellaria have been described and illustrated. The paper is thus a first contribution to a study of the South Indian Cretaceous Radiolaria, about which we now know so little.

34. On the age of the Dudkur fossiliferous beds, Madras Presidency.

H. C. DAS-GUPTA, Calcutta.

The fossiliferous beds at Dudkur (17° 2′: 81° 38′) were first recognised by King in 1880 who relegated them to the infra-trappean. The beds were visited by the author with a party of students and fossils collected. A preliminary examination of the fossils reveals the presence of *Venericardia Beaumonti*, d' Archiac. The age of the beds is discussed and the author concludes that the beds should be regarded as inter-trappean and not infra-trappean.

35. Additional fossil localities in the Upper Tertiaries of the Garo Hills, Assam.

P. EVANS, W. B. METRE, *and* B. H. SINGH, Digboi.

In view of the rarity of fossils in Assam special interest attaches to the two fossil beds found by Mr. Pinfold in the southern portion of the Garo Hills (*Rec. Geol. Surv. Ind.*, Vol. L, Part 2). A third fossil locality having recently been found by Dr. Fox, the junior authors, working under the direction of Messrs. Sale and Evans for the Burmah Oil Company were instructed to search for additional localities in this area. Nineteen new fossil occurrences were discovered, nine near Baghmara (25° 12′: 90° 38′) and ten north of Dalu (25° 13′: 90° 13′).

The nummulite-bearing Eocene limestone and shales are unconformably overlain by Upper Tertiary beds. The lower portion of these is mainly alternations of sandstone and shale and the higher portion, in which the fossil beds occur, is made up of sandstones, grits, conglomerates, sandy shales and mudstones. From the work of Messrs. Vredenburg, Mukherjee and Eames the fossil beds are to be regarded as approximately Upper Gaj or Burdigalian.

The paper describes in detail the position of all the better localities discovered by the junior authors and summarizes the less important localities, and is accompanied by maps which should enable other workers to identify the position of each bed.

The writers are indebted to Messrs. The Burmah Oil Company for permission to publish this paper.

36. The Kanchanpur fossil bed.

H. M. SALE, Badarpurghat.

Owing to the rarity of fossils in the Upper Tertiaries of the Surma Valley a special interest is attached to the fossil bed at Kanchanpur (24° 39′: 92° 31′), to which reference was first made in the *General Report of the Geological Survey of India* for 1927. In this locality in Cachar a comparatively rich marine fauna of Lower Miocene age occurs in a thin fossiliferous bed which is placed stratigraphically in the uppermost beds of the Bhuban Stage.

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Presidential Address.

RECENT DEVELOPMENTS IN MEDICAL RESEARCH WITH PARTICULAR REFERENCE TO INDIA.

LADIES AND GENTLEMEN,

Lt.-Col. A. D. Stewart, I.M.S., Director of the Institute of Hygiene, Calcutta, was to have been president of this section but to our great regret he has unfortunately not been able to attend. On my recent return from home leave your committee asked me to take his place. While thanking you for this honour, I ask your indulgence for both the choice and subject matter of this address which has been prepared very hurriedly. Subjects that I was working at myself were written up and sent for publication before going on leave, so failing lines of work of my own, I thought it would interest you to hear a short account of what I think are the chief developments in recent medical research work illustrated as far as possible by details of work in India. In this I have been greatly helped by attendance at the recent conference in Calcutta of workers under the Indian Research Fund Association.

2. I shall begin with the subject which I suppose loomed largest in the earliest days of all of us—the subject of Nutrition. Deficiency and Deficiency Diseases we have all heard of. Indeed we hear too much of it. Almost daily we medical men are bombarded by advertisements extolling the merits of proprietary preparations in their content of vitamins, that now vary from A to E, but threaten to extend from A to Z. No, the new idea is not Deficiency but is *Disproportion*. It has been definitely shown that a *disproportion* or lack of balance of certain constituents of a dietary combined with vitamin deficiency will produce pathological conditions. This is well exemplified by some work of the Indian Research Fund's Nutritional Research at Coonoor under Col. McCarrison, I.M.S., on the production of stone in the bladder by certain unbalanced diets.

(*a*) In white rats a diet of white bread yeast and distilled water was found to invariably produce stones of the ammonium magnesium phosphate variety. This stone-producing action could be completely counteracted by the addition of sufficient whole milk or butter or cod-liver oil, i.e., by adding vitamin A, for, the essential fault of this diet is that it is deficient in vitamin A.

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16. Sir M. Visweshwarayya, K.C.I.E., M.Inst.C.E., D.Sc., Bangalore.
17. Dr. M. O. Forster, F.R.S., Bangalore.
18. Sir J. C. Bose, Kt., C.S.I., C.I.E., D.Sc., F.R.S., F.A.S.B., Calcutta.
19. Sir C. V. Raman, Kt., M.A., D.Sc., F.R.S., F.A.S.B., Calcutta.
20. Col. Sir S. R. Christophers, Kt., C.I.E., O.B.E., K.H.P., F.R.S., I.M.S., F.A.S.B., Kasauli.

(c) *Sectional Presidents for the Session.*

21. G. N. Rangaswamy Ayyangar, Esq., B.A., I.A.S.
22. Prof. Ganesh Prasad, M.A., D.Sc.
23. P. Rây, Esq., M.A.
24. Prof. D. R. Bhattacharya, D.Sc.
25. Dr. Haraprasad Chaudhuri, M.A., Ph.D., D.I.C.
26. P. Evans, Esq., B.A., F.G.S.
27. Lt.-Col. H. H. King, M.B., B.S., I.M.S.
28. J. P. Mills, Esq., M.A., I.C.S., F.A.S.B.
29. N. S. N. Sastry, Esq., M.A.

(d) *Permanent Members elected by General Committee.*

30. Dr. Haraprasad Chaudhuri, M.A., Ph.D., D.I.C., Lahore.
31. Dr. M. A. Sampathkumaran, M.A., Ph.D., Bangalore.
32. Dr. R. Gopala Iyer, Ph.D., Madras.
33. Dr. J. N. Ray, D.Sc., Lahore.
34. Dr. T. Bhaskara Menon, M.D., M.R.C.P., Madras.

(*b*) If to this stone-producing diet lime were added, then the stones produced were compounds of calcium, either the carbonate or hydroxide or a mixture of both, further these stone were multiple like grains of shot and there was also a great tendency for infections of the urinary tract to occur. It is to be noted that in this second diet we have not only a deficiency of vitamin A but also an excess of a mineral element—Calcium. While the stone-producing property of this second diet could be counteracted by giving vitamin A, it is important to note that this did not diminish the *excretion* of calcium by the kidneys, which still went on to the same high degree as before. This excretion was not diminished until more *phosphates* were added to the diet in the shape of sodium *phosphate*, when the excretion of calcium compounds by the kidneys was diminished and their excretion by the gut in the fæces was increased. Further it was found that when an excess of lime in the diet was balanced by increasing the phosphates in this way, that very little vitamin A was required to prevent stone and to promote health. Thus this second diet needed to be corrected not only by adding vitamin A but also by adding phosphates and so restoring the *relative proportion* of compounds of calcium and phosphorous. It was not the absolute excess of calcium in the diet that mattered, but it was the *disproportion* or disturbance of the proper ratio of these two elements that threw extra work on the kidneys and caused disease.

(*c*) As regards the action of vitamin A. It was found that however else it acts, it seemed to control the total *volume* of urine. When the vitamin was insufficient, the volume of urine was abnormally low, when sufficient vitamin A was added the value of urine excreted returned to normal. Obviously stones are more likely to form when the volume of urine is small.

(*d*) The importance of these observations in the *prevention* of this disease both in men and in animals is enormous. This is well seen by further observations made on stone in cattle. These stones are of the multiple variety like the calcium stones in rats on the second diet and also closely correspond to them in chemical compositions. An inquiry into the diet of these cattle revealed the fact that very often the diet was only rice and other straw plus ground nut husks and the empty pods of legumes, i.e., a diet with the same faults as the experimental diet—a deficiency of vitamin with an excess of lime unbalanced by a corresponding increase in phosphates. A detail will show the correctness of this idea of the diet being the cause of stone in cattle. These stones are laminated and it was thought that probably the lamination was due to intermittency of the error in diet, because of course cattle get green fodder after a monsoon.

By periodically changing from a normal to the abnormal diet mentioned, the stones in rats were also made laminated thus confirming the previous conclusion.

The importance of this successful research lies not only in the means it gives us to prevent the occurrence of most cases of stone in men and of nearly all in domestic animals, but lies, to my mind, far more in the light that it throws on the method of action of lack of balance in diets. The throwing of too great a strain on a particular organ is very significant. Perhaps much of the chronic inflammations or impaired functions of various organs and tissues are due to persistent long continued lack of balance and deficiencies of diet to a degree not sufficient to produce gross changes. The subject is in its infancy but a great step forward has been taken, and in this step we are proud that India has taken such a great share.

3. My next subject is advances in knowledge of that group of infective agents that we call viruses in the strict sense, meaning those agents that are so small that they are invisible by ordinary light at all stages of their life history, apart that is from certain bodies in cells of which nothing is certainly known but which may possibly be aggregations of the virus. As you are aware, of recent years the virus group has come more and more to the fore as the causal agents of disease, not only in men and animals but also in plants.

Yellow fever of which we in India fortunately know nothing, has been shown to be a virus disease, and it is interesting to note that this discovery and the fact that as in so many other cases the virus will keep alive when a bit of infected tissue is kept in diluted glycerine, has led to legislative action almost all the world over forbidding the importation of such virus. This gives one some idea of the immense possibility not only for good but also for evil that science is putting into our hands. Here in India we are troubled with dengue, which must also be due to a virus and apparently a virus closely allied to yellow fever, for it has been stated that dengue gives some protection against yellow fever. Dog distemper has also been shown to be due to a virus and a formalinised vaccine shown to be useful. What will interest most of us here, both medical and lay, is that recent work points to coryza, the ordinary cold in the head, being due to a virus. Thus recently workers in America have been able to infect both men and apes with a bacteria free filtrate of the nasal secretions of coryza cases. Thus in one experiment, 9 out of 15 cases were successfully infected. It has also been claimed that the virus has been cultivated in vitro. There is nowadays always an element of doubt in claiming that an agent is a virus in the strict sense, for it may be a filterable invisible form of a bacterium. Thus it is

now suspected that the virus of tropical typhus is a filterable form of B proteus, and that this is the reason why the serum of typhus cases agglutinates this bacillus which phenomenon has hitherto seemed a strange anomaly. Further we know that under the action of bacteriophage some bacteria may become filterable. We will consider bacteriophage later, to return to viruses. We are not only learning about new viruses but are also—thanks to tissue culture—learning how to culture them. Thus vaccinia virus has been cultured recently even as a simple culture, and perhaps the day will come when all our vaccine lymph will be grown not on calves but in flasks. Meanwhile we have an advance to record in the animal culture of vaccine lymph. One of our duties at the King Institute is to manufacture vaccine lymph for the Madras Presidency. So naturally we were greatly concerned when cases of post-vaccinial encephalitis were reported from several countries particularly from Holland. Fortunately it does not appear to have occurred in South India, for all Health Officers were asked whether they knew of any such cases and the answer was in the negative. Now one of the theories advanced as to the cause of vaccinial encephalitis was that a new extraneous virus had been picked up by the lympth in its passage through the rabbit for, as you must know, following the work of Nijland it is customary to maintain the potency of vaccine lymph by at least occasional passages through a rabbit. At the King Institute we had long adopted Nijland's full cycle for vaccine lymph on ox-calf, rabbit, buffalo-calf and then the ox-calf again, the calf lymph being used for man. Though the suggestion that encephalitis was due to a virus picked up from the rabbit was not very likely to be correct, I thought it would be wise to take every precaution, and so modified this passage cycle by introducing another buffalo into it with the idea of further diluting the actual material that was obtained from the rabbit. Thus the cycle in the last two years has been calf, rabbit, buffalo, buffalo and then the calf again. The interesting thing to note about this modification is that it has definitely increased the potency and total yield of lymph from the final ox-calf passage. Dilutions of 1 in 1,500 give continuous vesiculation on calves and the average yield per calf—we use a very small breed of calf, has risen from 23 grammes to 27 grammes. We have noted that whereas the second buffalo does not take well, the seed lymph taken from it has this good effect on calves. So I suggest that effect of this extra passage is to provide conditions where only the stronger strains survive without being damaged. In this we have an illustration of a law applicable to all organisms including man that, for the production of strength and vigour, an environment should not be too favourable, i.e., it should not permit the survival of the weakest strains. This

is a law which we may very well commend to the notice of politicians and statesmen in these days of solicitude for our weaker brethren.

As previously mentioned my next subject is Bacteriophage —the agent, whatever it be, that causes transmissible lysis in bacteria. Its importance is obvious, for the phenomena hold out to us the possibility of controlling bacterial diseases by the employment of bacteriophage. Our advance in knowledge here is still rather puzzling. Firstly we do not know exactly what bacteriophage is though it seems very likely to be a virus attacking bacteria as d'Herelle first imagined, and secondly its phenomena are profoundly altering what we thought we know about bacteriology. So rapid and bewildering are the changes that I hesitate to mention this subject, but it will be of interest to recapitulate the main facts known about bacteriophage taking as our example cholera bacteriophage which has been the most studied—I may say here, that in India great advances in our knowledge have been made both by the work of the Indian Research Fund Association Bacteriophage Enquiry under Dr. Asheshov at Patna, and by the work of several others in laboratories in India.

(1) Cholera Bacteriophage appears to act as a living infective agent of cholera vibrios in that it multiplies, breeds true to type, varies in virulence and can be separated by filtration from its host, live for a time and again be made to contaminate a culture and show its ordinary action. A possible objection to this is that a bacteriophage never is separated from its host and that we are dealing with phenomena associated only with the bacteria themselves and with their capacity to undergo either autolysis or to pass into a filterable and still living state.

(2) Cholera Bacteriophage exists in at least three types, a quicker acting A type and slower acting B and C types. The importance of the existence of these types lies not in their separate existence and action, but in the fact that a strain of vibrios lysed by one type will later grow secondary cultures resistant to that type but lysable by the others. So all these types are necessary to ensure permanent lysis of a culture.

(3) As regards virulence not only do strains of bacteriophage vary in virulence but strains of cholera vibrios vary greatly in susceptibility to the action of phage. Bacteriophage tends to lose its virulence under laboratory conditions unless supplied from time to time with susceptible vibrios.

(4) Bacteriophage does not appear to develop in uncontaminated cultures. It appears to arise in nature, and I think I am correct in saying that it is more readily isolated in the course or towards the end of epidemics than at the beginning. Its not arising *de novo* in cultures rather goes against the

autolytic enzyme theory, but it is still not clear whether bacteriophage is a true living agent in which each specimen has arisen from a previously existing one. If we suppose that it is such an agent, then we must suppose that at times it loses its virulence and lives more or less symbiotically with or rather on the cholera vibrio as a sort of harmless commensal, for only in that way can we imagine that such a virus would live in the intervals between cholera epidemics. Recently Dr. Asheshov has produced evidence that bacteriophage living in this symbiotic way with cholera vibrios is actually found in nature. He reports that he cannot separate such quiescent bacteriophage from the vibrios until he acts on these vibrios by a laboratory bacteriophage *of another type*, after which the first pre-existing bacteriophage is set free and it can be made virulent by being allowed to act on susceptible strains.

(5) Cholera Bacteriophage has been tried in the treatment of cholera but with varying success. The Infectious Diseases Hospital, Madras, at our request treated alternate unselected cases with phage—the number of cases is rather small, only 17 on each side, but the mortality on the phage side was much less—just a little more than half that of those not so treated. Four cases died as compared with eight of the untreated. Other reported results have not been so good so the matter is still unsettled. What is wanted is a trial in a large number of alternate cases of a potent poly virulent bacteriophage, for we should not expect success except from the use of such a phage. Bacteriophage is also being used to prevent the spread of epidemics by using it at large melas and similar gathering where cholera epidemics start and by using it as soon as cholera is reported. Though the facts are very suggestive of success they are not yet conclusive, so this use of phage too must be considered as being still in the experimental stage.

(6) Finally we have the light shed on the diagnosis of cholera vibrios. It has long been accepted by most bacteriologists that non-agglutinating vibrios that are from time to time found in water are not true cholera vibrios but are harmless free living vibrios. This is now very doubtful. For we know that the agglutinating properties of vibrios are very much changed by the action of phage. Some workers say that they have changed agglutining vibrios into non-agglutinating and *vice versa*. Here too finality has not been reached and we must suspend our judgment until more work has been done before we can decide that all non-agglutinating water vibrios are changed cholera vibrios. It is certainly a fact that some non-agglutining vibrios are cholera vibrios.

My fourth subject is the importance of the species factor in the transmission of disease by intermediate hosts and I

shall exemplify this by the conclusions drawn by Dr. Pandit and myself on a recent rat flea survey of the Madras Presidency done under the Indian Research Fund Association. I was not going to mention this work as it was published six months ago, but since coming to Bangalore I have realised how great the interest is taken locally in plague at the present time when rat falls have been reported, so I sent to Madras for a few slides which I will show you to let you see why we concluded from our survey that the species X. cheopis was far and away the most effective carrier of plague in South India thus upholding the correctness of Dr. Hirst's views so far as South India is concerned.

(Here several lantern slides were shown illustrating the association of plague with the infestation of rats with X. cheopis.)

In the main chart we see that despite the absence of complete data, there appears to be a very definite association between cheopis prevalence and the occurrence of severity of plague. This is particularly apparent in some of the west to east or south-east lines from the main plateau to the coast.

(1) The North Mysore—Pennaru River Line—Harpanahalli, Hospet, Bellary, Guntakkal, Proddatur, Cuddapah, and Nellore.

(2) A central rather irregular line—Hosur, Madanapalli, Tirupattur, Chittoor, Vellore, Tirupathi, and Madras. It is to be noted that the specific indices for the first two places are much higher than for the others.

(3) The Cauvery River Line—Coimbatore, Salem, Trichinopoly, Tanjore, and Negapatam.

(4) A Southern Line—the Kumbum Valley, Dindigul, Madura, Tinnevelly, and Tuticorin.

Note how the places at the head of the lines are either on or close to the main plateau, the region of cheopis abundance, and how the ends of the lines, where plague is practically absent, are in the cheopis-free region of the Central and South-East Coast plains; similarly the hill station group of Ootacamund, Yercaud, and Tirumalai with plague practically absent in the last two. The West Coast Line—Mangalore, Calicut, and Cochin shows cheopis and plague in the first two but not in Cochin which is free from cheopis. There are two exceptions to the general rule as can be seen both from the map and from the table. The first is on the Central Line—Madanapalli which has had less infection than one would have expected. It is not on a railway and is quite out of the line of ordinary trade traffic. So the comparative absence of importation of infection is the explanation of its relative freedom. This is probably also partly the explanation why, as our second exception, in the northern half of the East Coast plain, Vizagapatam and Berhampore have had little or no plague, despite high cheopis infestation. A

further possibility is that, whereas the climatic conditions here are suitable for cheopis, they are not suitable for the other factors in plague transmission.

What we have to remember, before associating, the association of cheopis prevalence with plague, is that possibly the demonstrated association of plague with cheopis prevalence may be entirely spurious. For it may be, that both plague and cheopis prevalence are directly correlated with climate, and so may appear to be correlated with each other, despite the possible absence of any connecting causative factors. Against this there stands out the salient fact that the places mentioned previously which are free from cheopis and where the climate is eminently suitable for plague have had either no plague, or when it did appear, suffered very little.

Cochin, a port on the West Coast which is exposed to infection from other West Coast ports and from the hinterland and which has a climate similar to Mangalore, Calicut, and Colombo which all have plague, has had no plague at all in the British area and only 14 cases in an epidemic in Mattacherry which adjoins it.

Bellary Cantonment on the main plateau with only astia has had only seven cases of plague in the last 16 years. It adjoins the town of Bellary where both cheopis and plague abound. Being a Cantonment, its sanitation is of course better than that of the town, but this alone will not account for the vast difference.

Yercaud, a hill station in the Shevaroy Hills, 4,500 feet high and so with a climate favourable for plague, is only 11 miles from the endemic plague centre of Salem through which nearly all its traffic passes, despite which it has had only two small epidemics of plague with 17 deaths—it has no cheopis, only astia and braziliensis.

Tirumalai, 2,800 feet with a climate suitable for cheopis, is exposed to infection because it is visited by many pilgrims. It has had no plague. Only astia were found.

Therefore we conclude that the association between cheopis prevalence and plague is probably not wholly due to their both being correlated with climate. Before leaving this map, note how the areas both of greatest plague and of greatest cheopis prevalence cluster round the Mysore plateau. This is associated not only with cheopis prevalence in this region, but also with frequent importations of infection from Mysore State where plague is practically endemic. Other areas from which plague is imported are the Bombay Deccan, the Nizam's dominions, and from the more heavily infected districts of the Presidency itself. The influence of both these factors is well shown by the map giving the years in which plague mortality in districts first exceeded 1 per 100,000 of population (2).

From Bombay in 1896, through the southern parts of the Bombay Presidency and Nizam's dominions in 1897 plague reached the Madras Presidency in 1898 with severe epidemics in some districts. Districts so infected in the first 5 years, 1898–1907, are cross hatched. They are seen to cluster round Mysore. Districts seriously infected in the next 10 years are single hatched, and those similarly infected in the next 17 years are dotted. Districts practically free from plague, i.e., with a mortality less than 1 in 100,000 in any year, are left blank. In interpreting the map two points must be remembered. First, that these are figures for districts whereas our own survey figures are for towns and adjacent villages. Second, that the map does not represent the time of the first infection, but only of the first epidemic yielding a mortality exceeding one death per 100,000 for the district. Thus in the first year 1898, plague was imported into 96 different places in 11 districts, but established itself in only 20 centres in 5 districts—Bellary, etc. This emphasizes that earliness of infection on the map shows not only early infection, but also the existence of conditions suitable for epidemics. It is very evident that the map shows a general correspondence between the proportion of cheopis previously described in the surveyed towns of a district and the earliness of serious epidemics in the district.

The Chart giving the district mortality curves per 100,000 per year shows that Bellary District is the most affected by plague, and that next come Coimbatore and Salem districts. The heavy intensity in the first two areas is probably associated with the cotton trade and the facilities it gives to the import of fleas. These figures for districts remind us that we need more information on rural conditions.

In several places where cheopis was absent and astia or astia and braziliensis abundant, plague has either not occurred at all or has caused only a few mild epidemics. All places surveyed in which astia was by far the predominant flea and in which there has been some plague, however little, are noted in a table. It is very evident that in all these places not only have the epidemics been very few, and very small, but what is far more important they have not carried over from one season to another. The evidence is so definite that there is no need to labour the point, that, places where practically only astia exists, are not likely to get severe and recurrent epidemics. It may again be objected, that this is not because the fleas are practically only astia, but because the climatic conditions are not favourable to plague transmission. But this is not the case for the climate during the North-East Monsoon and during the cold weather is quite suitable.

The evidence that the association of plague with cheopis is not wholly due to a common association with climate is very much strengthened if we consider the cool weather climates of the typical astia zone in the South-East plain. Here, after the onset of the North-East Monsoon in October, for the next 4 months we have a climate eminently suitable for plague propagation, but it does not occur, despite flea indices that are quite high enough for plague epidemics did they refer to cheopis, e.g., Madras residences gave an astia index of 5·8 in the cold weather. When it is borne in mind that in these places the rats are highly susceptible to plague, far more so than in cheopis areas, and when further it is remembered that many of these places are important trade centres receiving plague infection both from outside ports and from the western hinterland, then we think that the evidence is good enough to allow us to conclude that in South India the flea species factor is of the first importance in the spread of plague under natural conditions, and that X. cheopis is undoubtedly the chief vector, far more efficient than the common indigenous flea, X. astia, and possibly more efficient than X. braziliensis, the plateau flea, but there is not enough evidence for this second comparison. Webster and Goyle have clearly shown in their important experiments that astia freely conveys plague. But we must remember that the transmission of plague in laboratory experiments is apt to be deceptive as to the part played by each species in nature, unless care be taken to imitate natural conditions as far as possible, with due regard to the general environment, facility of contact of fleas with rats, and the flea density. As regards this last point, we understand that Webster in his recent work at Bombay concludes that astia needs a higher index to convey plague than does cheopis.

So far as South India is concerned our survey confirms the theory of Hirst which was supported by Cragg that plague in India is mainly caused by cheopis.

We are so struck both with the far greater efficiency of cheopis as a vector in nature and with the evidence that the species is of comparatively recent introduction, that we suggest that the explanation of the recent history of plague in India from 1896 onwards and why this is different from previously recorded epidemics which rapidly died out, is that whereas previous epidemics occurred in the absence of cheopis, the 1896 infection occurred when cheopis was fairly widespread throughout India as a whole. We suggest that the dissemination of cheopis occurred after the extension of human intercourse and trade (particularly the cotton trade) with Egypt following the opening of the Suez Canal in 1869.

My fifth subject is advances in the mechanisms of Research.

(1) Mathematics.—Nowadays research workers have often to get the help of a statistician and most commonly for tests for the *significance* of results. Thus a vaccine is tried in 20 rabbits with another 20 as a control, in the treated 8 die, in the untreated 12 die. Are these chance results or are they, as we say, *significant* of benefit having been secured by the vaccine? This problem is of fundamental importance in research and I have recently completed a paper showing that present methods adopting as they do only one hypothesis—usually that of homogeneity, and calculating a certain summed chance, *are not consistent* in their measurement of significance in different problems. I am suggesting a new method based on calculating the average chances of getting the given results on the only two possible hypotheses, those of homogeneity and heterogeneity, and taking the ratio of their chances as a measure of the significance of the results. With the mathematical details of this I shall not worry you.

(2) In physical methods we have many advances to record. Micro-photography by ultra-violet light has shown us bodies that are too small to be visible by ordinary light. Micro-kinematic photography has rendered visible for us the actual movements and steps in the reproduction of cells and tissues. The cataphoresis of cells and bacteria and probably too of virus gives us a new mechanism of research that is of great importance.

(3) To chemists we have long been indebted and the debt is being increased by much work of which I shall mention only two instances. First, the investigation of the chemical structure of vitamins. I understand that vitamins A and D have been isolated as pure chemical substances. Second, the analysis of blood serum in health or disease. Some work in this direction by Lt.-Col. Lloyd at Calcutta for the Indian Research Fund Association is of particular interest. He has shown that while the successful treatment of Kala-azar with Antimony is associated with a sudden drop in the pseudoglobulin content of the blood serum, the treatment of syphilis by specific drugs is associated with a much smaller similar change. Accordingly he suggests a search be made for drugs that in syphilis will cause a much larger drop in the pseudoglobulin content, for such will almost certainly be associated with greater success in treatment. He also concludes that whether the serum of a syphilitic will react positively or negatively to a Wassermann test depends on the quantitative relation between the total globulin and the albumin, i.e., on the protein ratio. In the first place when the albumin is reduced the Wassermann is positive. When in the second place the albumin rises to its normal excess over the globulin its protective action is rearrested and the Wassermann becomes negative.

General.

The nineteenth meeting of the Indian Science Congress was held in Bangalore from January 2nd to 8th, 1932.

The inaugural meeting was held on Saturday, January 2nd, 1932, at 6 P.M. in the Intermediate College Hall, Bangalore. Dr. E. P. Metcalfe, D.Sc., F.Inst.P., Vice-Chancellor of the Mysore University, and Chairman of the Local Reception Committee, welcomed the delegates in a short speech, after which Sir Mirza Mahomed Ismail, C.B.E., C.I.E., Dewan of Mysore, read out a Message of Welcome from His Highness the Maharaja of Mysore, and opened the Congress with a short speech. The President of the Congress, Rai Bahadur Prof. S. R. Kashyap, B.A., M.Sc., I.E.S., then delivered his address.

The Sectional Presidential Addresses were delivered as follows:—

MONDAY, *January 4th*, 10 A.M., Chemistry; 11 A.M., Botany; 12 NOON, Agriculture.

TUESDAY, *January 5th*, 10 A.M., Mathematics and Physics; 11 A.M., Zoology; 12 NOON, Medical and Veterinary Research.

WEDNESDAY, *January 6th*, 10 A.M., Geology; 11 A.M., Psychology; 12 NOON, Anthropology.

The following functions were arranged in connection with the Congress:—

SUNDAY, *January 3rd*, Whole-day excursion to Sivasamudram.

MONDAY, *January 4th*, 2-30 P.M. to 5 P.M., visits to:—

1. Minerva Mills Co., Ltd.
2. White Lead Syndicate.
3. Bangalore Silk Filature.

4-30 P.M., Mr. D. N. Sirur, Managing Director, Mysore Spinning, Weaving and Manufacturing Co., Ltd., and Minerva Mills Ltd., 'At Home' to delegates at the Minerva Mills Ltd.

TUESDAY, *January 5th*, 8 A.M. to 11 A.M., and 2-30 P.M. to 4-30 P.M., visits to:—

1. Government Agricultural Farm, Hebbal.
2. Serum Institute, Hebbal.
3. Bangalore Woollen and Silk Mills Co.
4. Mysore Spinning, Weaving and Manufacturing Co., Ltd.
5. Government Soap Factory.

My last subject is the special needs of India with regard to medical matters. Here I may cause some heart burning, but it is not those who love India least who are the most outspoken on the existence of evils, so I will say what I think. These are days of democracy, of health organisations, etc. In the attempt to educate and enlist the support of the public we have health and baby weeks which I notice tend more to become baby weeks rather than health weeks. Much attention is invited to the proper feeding, washing, and rearing of babies while the more important subject of *sanitation* is comparatively neglected. More important I say, for defective sanitation both in the disposal of excreta and in the production of conditions favouring insect or other carriers of disease produces ill health and death in man and woman of all ages including the prime of life. It is the death at this stage of mothers and fathers that is so distressing not only emotionally but also economically. In comparison, the death of many babies is of no importance—indeed in a crowded country like India it might even be considered a relief until birth control became better known. So let us put first things first and begin with the A, B, C of Health which is Sanitation. A glance at the chart from the last Annual Report of the Sanitary Commissioner for India shows you at first sight the number of cholera deaths per year in the last 50 years which as you see are sometimes $\frac{3}{4}$ million a year. On second thoughts however the chart will show you something more, for the prevalence of cholera is a good *index of the sanitary condition* of a country and so of the number of the many other diseases—dysenteries, diarrhœas, typhoids, worm diseases, etc.—that are caused by defective sanitation in the narrow sense of referring to the disposal of excreta. So fai as these diseases go you can multiply the average cholera ratio by some factor such as 4 or 5 or more if you wish to estimate the death rate largely due to defective sanitation. Defective sanitation as regards insect vectors plays a tremendous part, for half the total mortality is due to 'fevers' so called of which many are insect borne—here malaria plays the greatest part. Accordingly, to my mind what India needs most is the improvement of general sanitation particularly in rural areas. Praiseworthy efforts in this direction are being made in Madura district by the construction of bore-hole latrines. While research is needed in many ways, particularly that the measures suggested may be within the means of the people, propaganda is also needed that the conscience of the people be aroused to cut aside all habits and prejudices that hinder India becoming the healthy and happy country we should all like to see it.

Section of Medical and Veterinary Research.

Abstracts.

1. A suitable formula of Ringer's solution for perfusion work on the hearts of Indian frogs.

S. A. Rahman *and* R. N. Abhyankar, Hyderabad, Deccan.

In his work on 'The Action of Erythrophloeine on the Heart', Hardikar found Ringer's solution unsuitable for perfusion work on the heart of the Indian frog, R. tigrana, whereas he found the same solution to be quite satisfactory in Edinburgh where he used R. temporaria.

In order to find out a solution, free from blood, which would be suitable for perfusion work on the hearts of Indian frogs, we tried different formulæ. We found the formula recommended by Bayliss for frog's heart in general to be quite suitable for Indian frogs also, the heart continuing to beat regularly for many hours.

2. Environment as a factor modifying the manifestations and treatment of syphilis in South India.

D. V. Subba Reddy, Vizagapatam.

I. Heat as a modifying influence on syphilis.

(*a*) Animal experiments of Weinhboldt and Jahuel of Schamberg and Rule, of Beosemans and co-workers, cited to show that heat therapy has a marked curative influence on experimental syphilis.

(*b*) Clinical investigation of Stokes of Muhlens, of Mahrtens and Puuppirt are referred to bring out the good results of pyretotherapy. Effects of hot air and hot water baths on elevation of skin temperatures on immunity reactions and on central nervous system are discussed mentioning the ranges of temperature tolerated by the body.

(*c*) Clinical observations on the smaller incidence of Neurosyphilis in tropics.

(*d*) Note on the high temperatures of the atmosphere in shade (with data and tables) in South India with possible influence of these temperatures on the skin temperatures, tissues, bacteria, immunity reactions and chemotherapeutic agents.

(*e*) Direct exposure to sun—Life and habits of peoples facilitating sun baths. Sun Thermometer readings. Heating up of human body to various depths by infra-red and luminous rays. Experiments of Carl Sonne indicating degrees of heating at different depths in the body. Author's experiments with direct exposure to sun's rays. Effect of fever therapy with reference to specific drugs in circulation.

(*f*) Conclusion—Thermal environment acts as a type of heat therapy modifying tissue reactions and altering the natural history of disease.

II. Helio-therapy as an adjuvant in the treatment of syphilis.

(*a*) Animal experiments of Brown and Pearce showing the beneficent influence of sun light on syphilis.

(*b*) Clinical observations of Russel and Russel, of Rajka and Rednai, of Rollier, and of Huldsinsky.
(*c*) Duration of sunshine (tables), latitude, rural character, scarcity of smoke nuisance give greater intensity and higher proportion of U.V. rays in sun light and sky shine.
(*d*) Effect of the three kinds of rays (infra-red, luminous, actinic) in the sun light on human body on the micro-organisms, on chemotherapeutic drugs in circulation, etc.

III. Effect of atmospheric temperatures and of natural environment of air and light on the activity of the skin, especially as an immunological organ. Effect of different drugs and their combinations like mercury, sulphur, gold, arsenic, etc., modified by heat light and diet of South India.

IV. Need for research to chalk out a scientific course of treatment to suit the conditions in South India.

3. Effect of chloroform on the cholesterol content in pigeons.

N. C. DATTA, Bangalore.

Different results have been obtained by different workers on the variation of blood cholesterol under the action of chloroform and ether. In ether anæsthesia in man, blood cholesterol was found to increase. By repeated inhalation of chloroform the serum cholesterol in rabbit was found to increase whereas in dog it increases for the first 2 or 3 days of narcosis and then goes down to an unusually low value.

Pigeons have been subjected to chloroform inhalation for 1½ to 2 hours daily and blood cholesterol and red cell count have been determined once a week. Blood cholesterol increases slightly at first and then decreases slowly. Red cell count also decreases gradually. No definite relation between blood cholesterol and red cell count has yet been observed.

Normal cholesterol contents of blood and other organs, viz. brain, liver, gall bladder and heart have been determined and their significance discussed.

4. A further study of the vital capacity of the lungs in South Indian women.

ELEANOR D. MASON, Madras.

Measurements of heights, weights and vital capacity of 587 new South Indian women subjects are shown to have no significant variation from the measurements on 266 women recorded in an earlier paper. From the combined data regression equations are derived for vital capacity on height, weight and surface area and charts drawn for predicting average vital capacities from these three measurements.

Analysis of three race groups, Tamils, Malayalis and Telugus, shows that the Malayalis have a higher vital capacity. Comparative charts are drawn for the Tamil, Malayali, and American women. The average vital capacity for Indian women is found to be 76 per cent. of the average for American women of the same height as the Indian mean height.

The significance of the vital capacity measurement in health and disease and the question of racial influence on vital capacity are discussed.

5. Some maternity statistics.

V. N. POORNAPREGNA, K. V. KRISHNA SASTRY, *and* K. B. MADHAVA, Mysore.

This paper is mostly of statistical interest and reproduces an analysis of the data from parturition registers proved to be sufficient in size as to

be representative of conditions in hospital deliveries. The data have been compiled and analysed (by the first two mentioned authors) separately for twins (including triplet births), for stillbirths (including those described as born macerated) and cases which resulted in the hospital in maternal death. It is found that in most of the quantitative measures, and also in certain descriptive characters, there exist differences from similar constants for a universe of all hospital deliveries which must be considered statistically significant. Most of the differences are traced to the incomplete nature of the term of delivery or to the conditions peculiar to twin and stillbirths. Particulars of identical twins and of the observed differences in quantitative measures at birth among twins are also tabulated. The age (and therefore also the para) are shown to be higher among mothers delivering twin children and the converse is the fact in stillbirths. In the cases involving maternal mortality in hospital, besides these statistics certain particulars are given in regard to the interval between delivery and death and recorded causes of death. Finally in an attempt to determine whether large fluctuations, if any, could be located in mortality from month to month arising for instance out of an infective source or predisposing common cause a suggestion is made out that any long period of observation is probably made up of two parts—one period of a third part in length with constant risk, and another of twice this duration and of about four times intensity in risk varying according to the law of normal probability. Emphasis is laid in conclusion on the obvious fact that conditions in hospital deliveries are usually more 'complicated' than those in the general population.

6. 'Mosquitoes and Malaria'—effects of variation in parasitic virulence and hosts' susceptibility.

K. B. MADHAVA, Mysore.

Waite follows (*Biometrika*, Vol. VIII, 1910) Sir Ronald Ross's investigation (*Report*, 1908) of the relation between the number of mosquitoes in a locality and the malaria rate therein on the assumption of the latter's numerical estimates of the recovery rate (one-half in three months), and of the infectivity of anophelines (1/192 times the number of persons exposed to risk). Further, following this work but from a general symbolic consideration of these two constants, two theorems connecting the number of mosquitoes and the malaria rate with the host's varying capacity to resist and the parasite's virulence in introducing infection are brought to light :

(i) that in order to maintain a constant morbidity rate the product of the 'units of virulence' in the parasite and the number of anophelines (what may be called the total 'quanta or quantity' of infection) shall remain constant;

(ii) that from the points of view of (*a*) the proportion of anophelines per person in maintaining the sick list constant, (*b*) the proportions between old cases and fresh infections, and (*c*) the course of morbidity rates in successive months, the factor of parasitic virulence is of *less* importance than the factor of host's susceptibility

7. Incoercible vomiting during pregnancy and auto-hemotherapy.

Z. ANDRÉ, Pondicherry.

In medical practice, it occurs frequently that physicians have exhausted unsuccessfully the whole pharmacopœia in order to stop incoercible vomiting during pregnancy.

Sometimes, he thinks even to destroy the embryo in order to relieve the patient.

It is under these circumstances that auto-hemotherapy has given capital results by bringing rapid relief to the woman.

The paper records observations on a woman Mrs. X having incoercible vomiting during pregnancy. . . .

The technique is that of every auto-hemotherapy: daily injection of 10 to 20 cms. of blood in the buttock muscles for a week.

8. Grave intoxication following a local dressing with opium on a two years old child.

CAPTAIN TALEC *and* DAMODARIN, Karikal.

This child showed a large tumefaction in the temporo-maxillary region.

After the ineffectual local treatment by the family, the help of an empirical physician had been called in who had advised the use of raw opium on the injured part; the prostrate state in which the child remained for two days moved the family to call us for consultation.

The signs presented by the patient were as follows: conspicuous torpor, pupils tightly contracted without reaction to light, injected sclerotics, loss of appetite; refusing even liquid food, persisting constipation, bradycardia 55 a minute, light pulse almost imperceptible, slackened breathing—10 a minute, albuminous urine.

Treatment.—After incision of the phlegmon, injections of caffeine, camphorated oil, spartein repeated at intervals. Purge followed by washing away enema.

The young patient was cured on the third day.

9. Advantages of rachianaesthesia in the rural practice of surgery.

CAPTAIN TALEC, Karikal.

Advantages of rachianaesthesia on general anæsthesia with chloroform or ether in surgical operations in lower parts of the body, such as appendicitis, hernia, elephantiasis, hydrocele, amputation of lower limbs.

Difficult and often delicate choice of the anæsthetist, syncopal accidents, pulmonary complications so often observed. All these troubles are avoided by rachianaesthesia.

Personally I have done 113 rachianaesthesias without the least accident. This method nowadays in use at Karikal goes on giving us entire satisfaction.

Technical employment.—Sub-cutaneous injections of caffeine one hour before the operation—lumbar puncture at chosen point and slow injection after mixing, of the anæsthetic solution, with 5 per cent. of stovaine, thus easily prepared:

Stovaine—5 grammes.

Physiological serum—necessary quantity for 100 c.c.

This solution prepared and sterilized in water-bath and preserved in hermetically sealed bottles.

Doses.—In reducible hernia, hydrocele, amputations, small elephantiasis 1 c.c. of the solution, i.e. 5 centigrammes of stovaine is quite sufficient.

In voluminous elephantiasis in which the searching for the testicles mixed up in the lardaceous flesh is sometimes painful, in voluminous hernia (inguino-scrotal) for which a real dissection is often required, the dose must be increased to 1 c.c. and a half, i.e. 7 to 8 centigrammes of stovaine to obtain complete analgesia and perfect abdominal relaxation.

10. Some new applications of anæsthesia in daily therapeutics.

H. Aubin, Pondicherry.

Responsive sensibilisation of nerve centres to the drugs action (chloroformisation together with serotherapy antitetanic, etc.).

Anæsthesia of cutaneous region corresponding to visceral pain. Colic-hepatica, angina pectoris, pregnancy gastritis.

Obstetrical anæsthesia.

11. Implantation of the ureters into the bowel.

V. B. Green-Armytage.

My first implantation operation was performed in the Eden, in 1912, for ectopia vesicae on a girl of 12, both ureters were implanted on the same day and recovery was complete. In 1926, the patient returned pregnant and Caesarean Section was done. Inspired by the enthusiastic reports of Col. Fraser, in Madras, of a modified Coffey Technique, the author has devised a method which is within the means of every hospital surgeon in India, for those frequent and distressing cases of inoperable Vesico Vaginal Fistula and the more rare cases of Ectopia Vesicae.

The operative technique is also offered to genito-urinary surgeons, who are faced with cases of cancer of the bladder or prostate.

The accompanying illustrations make the steps of the operation easy to follow and I am much indebted to my house surgeon, Dr. Deb, for the excellent clarity of his wood block drawings—drawings which were done at the time of operation when I was implanting both ureters at one sitting.

A series of cases is given, and in two of them it will be seen that despite the fact that the patients had enormous fistulae and the vagina only just admitted a finger, the patients were pregnant at the time of operation and each weathered the storm of implantation of both ureters at one operation.

Despite the success of implanting both ureters at one sitting in two cases, the author had a serious setback when he lost two similar cases from uraemia. For this reason it will be seen that for a time, in subsequent cases, he implanted the second ureter a fortnight after the first, with a hundred per cent. success.

Thinking over the reason for the two deaths from uraemia, he came to the conclusion that it must have been due to an inflammatory exudation in the gutter wall of the bowel, compressing the ureters. In order to get over this problem he threaded into the cut ends of the ureters opaque flute ended catheters, the proximae ends of which he passed into the rectum and out of the anus by employing a home made prostatic catheter, the nose of which was screwed on and removable.

The catheters in the ureters now bore the brunt of the inflammatory exudation in the gutter wall, as was proved in the case No. 7, where despite pregnancy and post-operative pneumonia, the patient recovered, and there was immediate drainage of urine from both ureteric catheters.

The author gives the bibliography of the various operations performed and the success obtained by various surgeons.

12. On a Typhus like fever case at Pondicherry.

Major Labernadie, Pondicherry.

Case occurring on a 43 years old woman during an epidemic of typical *dengue*, which affected at the same time the daughter of the patient. Hence the interest of the differential diagnosis.

Signs and symptoms analogous with those described by Megaw, Ghose, Rao, etc.

Nodular eruption at the beginning becoming macular and at last petechial.

No 'porte d'entrée' recognised. At home, two dogs with innumerable ticks.

Discussion and serological results.

13. The treatment of asthma by intravenous injections of alcohol.

MAJOR LABERNADIE, Pondicherry.

Everybody knows how asthma is apt to resist the most varied treatments etiological, symptomatic, prophylactic.

General anæsthesia with chloroform gives fairly durable results, but it can only be an exceptional method.

We have tried to produce general anæsthesia with less risk by using the method of Miguel Garcia with alcohol, which causes a deep sleep, a method which is widely employed in South America in general surgery.

Having to treat an asthmatic patient, we operate as follows: a slow intravenous injection with the solution containing:

Alcohol at 95 per cent. extra pure: 15 c.c.
Solution glucose in water (at 240 0/00): 85 c.c.

The patient slowly goes to sleep and only wakes up a quarter of an hour afterwards. One injection is often sufficient to stop the fit and prevent its return. At other times several injections every day are necessary. It is rarely necessary:

(*a*) to double or triple the dose;
(*b*) to employ a solution of alcohol at 33 per cent.

This treatment well tolerated by the patients seems to be efficacious. This is undoubtedly due to:

(1) the general anæsthetic effect;
(2) the direct effect of alcohol upon the sympathetic system of which it is as good a stimulant as adrenaline.

14. Diagnosis and rational treatment of cholera.

P. T. PATEL, Bombay.

There is no disease so grave amongst infectious diseases commonly prevailing in this country as cholera and at the same time it is remarkable how valuable lives can be saved and incidence and mortality reduced to 10 or 15 per cent. by proper and rational methods of diagnosis and treatment. As such a vast amount of controversial and conflicting literature has appeared on the diagnosis and treatment of cholera it is necessary to take stock and to present a precise statement of the existing facts based on the statistics and one's personal experience.

All cases presenting acute gastro-intestinal symptoms with collapse should be suspected to be cholera and immediate steps should be taken to arrive at a correct diagnosis.

(i) The diagnosis of cholera is partly clinical but mainly bacteriological. Clinically it has to be distinguished from cases of food-poisoning and other diseases which closely simulate it. The bacteriological procedure found most effective in our experience is briefly described.

(ii) A brief historical review of the advances in the treatment of cholera; commencing with the castor oil treatment down to the present-day scientific methods is presented.

(iii) The scope of bacteriophage in the treatment is discussed. In 20 cases of our series no demonstrably potent strain of the phage could be isolated.

(iv) Statistics are given showing the effect of rational treatment and by which we have been able to reduce the ordinary mortality of epidemic cholera from 40 to 50 per cent. to a low mortality of 14 per cent. this year.

15. The treatment of asthma by chloroform.

Z. ANDRÉ, Pondicherry.

Specific treatment 'universal' for asthma is impossible due to the multiple causes of the sickness. That explains, partly, the so-called 'marvellous cures' obtained with empiric methods and also the poor results obtained with classical treatments that have been tested.

Moreover one must beware of certain new therapeutic methods which have been proposed during these last years and which may provoke dangerous reactions on the patient.

The treatment by chloroform which is harmless gives the maximum success.

The patient is given chloroform during the asthmatic attack. This new method has been tested with great success in the Colonial Hospital, Pondicherry, when other therapeutic treatment failed.

We must mention that the technique is the one used commonly, 25 c.c. of chloroform is given for at least half an hour to make the patient sleep and become insensible for as long a time as possible.

On his waking the patient is cured of the attack.

Moreover it is to be noticed with satisfaction that the painful asthmatic crisis never relapses in most of the patients treated in this manner.

16. The treatment of ascites by intraperitoneal injection of iodide-iodine.

MAJOR LABERNADIE *and* Z. ANDRÉ, Pondicherry.

In cases of ascites caused by hepatic cirrhosis, besides the etiological treatment, we operate as follows :—

(1) evacuation through puncture of the greater part of liquid, allowing at least two pints to remain in the cavity.

(2) slow injection through the needle left in its place of the following solution :—

Iodine	... ...	2 grammes.
Potassium iodide	...	4 grammes.
Water	... ...	100 grammes.

(3) The puncture is closed with collodium.

There always occurs a slight peritoneal reaction (temperature 100 to 102 F, slight abdominal aching; transient nausea) which lessens and disappears naturally in three or four days.

Punctures and injections must be repeated about once a week during two to four weeks.

The best results are obtained in cases of cirrhotic ascites. The method is not advisable in the case of an ascites of a cardiac or renal origin.

Hence a precise diagnosis is necessary.

17. Infective granuloma.

R. MAHADEVAN *and* W. HAPPER, Madras.

The paper is based on our experience of 70 cases of Infective Granuloma in the last two years during which time we have attempted to determine the exact cause and to work out the most suitable method of treatment.

Probably in most cases the disease is venereally acquired, but there is reason to believe, the condition may be acquired non-venereally also.

The ætiology is not yet established. Our attempts to find the probable causative organism by staining the scrapings by various methods, by inoculating the scrapings in various media in an effort to cultivate the organism, animal inoculation and inoculation into healthy individuals have all failed. Nor have these measures helped us to confirm the observations of others, claiming some particular organism or other as the causative factor.

Early cases are cured by urea stibamine. Late cases are resistant to it. Cases resistant to urea stibamine are resistant to all other drugs.

Radium is being tried and promises some success. The fungating type of granuloma is likely to be cured by it. Four cases which showed improvement with radium are detailed.

18. Infantile cirrhosis of liver.

A. C. SANKARA IYER, Mysore.

Geographical distribution of the disease in the Mysore State, in relation to rainfall, population and other environmental factors.

Age of onset, duration, sex and caste incidence of this disease.

Some important factors in its signs and symptoms.

Differential Diagnosis: Malaria, syphilis, rickets, kala-azar and typhoid.

Pathology:—

(a) Morbid anatomy and histology.
(b) Laboratory findings:—Haematological and bacteriological.
(c) Animal experiments.

Discussion of ætiological factors.

Some aspects of treatment of this disease.

19. An experimental contribution to the diagnosis of pernicious anæmia.

K. N. MURTHI *and* P. J. S. RAO, Madras.

Having been disappointed in demonstrating the toxicity of the serum of cases of pernicious anæmia on animals, the following phyto-pharmacological experiments were carried out.

A study of the growth of the seedlings of *Vigna catiang* in the serum of pernicious anæmia, secondary anæmia and normal serum, using Sach's solution as the control, has been made. We found Schonjahn's germinating apparatus as the most suitable for germinating the seeds. The growth of the tap root is measured for three consecutive days, in all the sera and their co-efficients of growth representing as percentages are calculated. The serum of pernicious anæmia is found to be distinctly toxic to the seedlings and suggests a profound disorder of metabolism in the pathogenesis of the disease. This phyto-toxic property is not shown by normal sera and secondary anæmia sera; and so this test is helpful as an aid in the differential diagnosis of this disease.

The authors regard their investigations to be still in an experimental stage, but they hold that these investigations are helpful in the elucidation of the (1) etiologic factor, (2) as a means of differential diagnosis, and (3) as a means of finding the effect of various forms of treatment as ultra-violet radiations, and other organic and inorganic sensitizers (illustrated with photographs). The tabular statements are appended.

20. Intercurrent infection in sprue.

G. E. MALCOMSON *and* K. N. MURTHI, Madras.

Four cases of *B. faecalis alkaligenes* were found during the past six months as a complication to sprue. There was apparently no connection between the cases. They occurred in three different wards at different

times. All the cases have been observed at the General Hospital, Madras, and were diagnosed to be sprue. They came to the hospital with 'relapsing sprue' with aggravated symptoms and fever. In the above group of cases typhoid and para-typhoid fevers, *B. coli* septicaemias were absent as complicating sprue.

The increased virulence of this comparatively mild disease as a complication in sprue was a most striking factor. Two of the four cases went down-hill so rapidly as to almost justify the term 'malignant sprue'.

21. Hypochrome anæmia.

G. E. MALCOMSON *and* R. VISWANATHAN, Madras.

(1) *History.*—This condition was first described by Watkins. Recently Theodore Waugh reported eight cases.

(2) *Pathogenesis.*—Perhaps here also as in pernicious anæmia we are dealing with a deficiency of gastric activity leading to incomplete formation of a chemical substance leading to dysfunction in the synthesis of Hb. Both of our cases had achlorhydria and negative Vanden Burgh. One was a female and the other a male.

(3) *Chief features.*—(*a*) Hypochromatic character. (*b*) High erythrocyte count. (*c*) Low Hb percentage. (*d*) Achlorhydria. (*e*) Resistance to treatment, R.B.C. count going up while Hb per cent. remains normal.

(4) *Treatment.*—Nothing seems to be of any avail. Liver, stomach, iron, heterohaemic or autohaemic therapy, or marmite did not raise the Hb percentage.

(5) Case reports.

22. Liver extract in diabetic mellitus.

M. N. BASAK, Calcutta.

For a long time liver has been considered as an unsuitable article of diet for diabetic patients due to its glycogenic content. But now experiments show that certain liver fractions contain some blood sugar reducing substances active when taken by mouth, non-toxic and with an effect on blood sugar similar to that obtained by insulin. These substances are ineffective in the treatment of pernicious anæmia.

The author has used an aqueous extract of the goat's raw whole liver pulp. The number of patients tried is very few yet the results are amazing; the amount of the raw pulp varies from one chittak to three chittaks in the cases.

In the cases usually the improvements in the clinical condition of the patients and reduction of the amount of the sugar in the urine have been used as criteria in estimating the liver effects.

23. Bromine in detection of adulteration of mustard oil.

B. B. BRAHMACHARI, Calcutta.

Linseed oil is a fairly frequent adulterant of mustard oil. Bromine is a reliable test for linseed oil. The existing methods are more or less complicated. The paper shows the process of application of the test to mustard oil in a simple form and yet giving fairly accurate results.

24. Vitamin value of the food fats of Bengal, a preliminary study.

B. B. BRAHMACHARI, Calcutta.

Of the two important food fats, mustard oil and ghee, vitamin content of the one is not known and of the other, practically so. The author

WEDNESDAY, *January 6th*, 9 A.M., and 3. P.M., visits to:—

1. Minto Ophthalmic Hospital.
2. Indian Institute of Science.

4-30 P.M., The Director of the Indian Institute of Science 'At Home'.

THURSDAY, *January 7th*, 8-30 A.M., and 2-30 P.M. to 5 P.M., visits to:—

1. Victoria Hospital.
2. Agricultural Laboratories.
3. Kaiser-i-Hind Woollen, Cotton and Silk Mills, Ltd.
4. Electric 'A' Station.
5. Laboratories of the University College of Engineering.

4-30 P.M., Vice-Chancellor of the Mysore University 'At Home', at the Intermediate College.

6 to 7 P.M., The Palace Indian Orchestra of H.H. The Maharaja of Mysore played at the Intermediate College.

9-30 to 11-45 P.M., Hindi Drama 'Prem Kabir', by the Members of the Amateur Dramatic Association, Bangalore.

FRIDAY, *January 8th*, Whole-day excursion to the Kolar Gold Field.

The popular lectures were delivered as follows:—

January 4th, 6-30 P.M., 'Recent Developments in Chemical Technology', by Prof. H. K. Sen, D.Sc.

January 5th, 6-30 P.M., 'New Wonders of Radio', by Prof. S. K. Mitra, D.Sc.

January 6th, 6-30 P.M., 'Sacred places of the Hindus in the Himalayas and beyond', by Rai Bahadur Prof. S. R. Kashyap, B.A., M.Sc., I.E S.

The *Council* of the Indian Science Congress met on the 2nd January, 1932, at 12 NOON.

The *Sectional Committees* met on the 2nd January, 1932, at 2-30 P.M.

The *Executive Committee* met on the 5th January, 1932, at 2 P.M.

The *General Committee* met on the 6th January, 1932, at 2 P.M.

placed seven rats of nine weeks on casein for protein, starch for carbohydrate, Drummond and Simmond's salt mixture for salts and yeast for vitamin B. A pair, both 50 grammes, got butter fat for fat throughout; the male grew to 150 grammes in 51 days, the female to 160 grammes on the 44th day and produced nine young ones the next day. The remaining five were depleted of vitamin on lard for fat for 23 days; then one got butter fat for fat, two, ghee and two, mustard oil. That getting butter fat gained 35 grammes in 21 days and recovered from xerophthalmia. The rest all lost weight, the two on mustard oil and one on ghee died, the other on ghee lingered with marked avitamosis and died subsequently. The fat and oil formed the entire fat of the diet and 16 per cent. of it. This shows that mustard oil has no vitamin and that ghee has very little.

25. Food value of kesur.

B. B. Brahmachari *and* N. K. Chatterjee, Calcutta.

Kesur grows wild in many parts of India. It is edible and on cultivation promises large yield. On analysis, it was found equal in value in proximate principles to potato and particularly rich in minerals, 440 grams. give 50 per cent. more than the average daily physiological requirement of iron, 25 per cent. of the phosphorous and 14 per cent. of the lime.

26. Fenugreek and augmentation in weight.

Z. André, Pondicherry.

Fenugreek, grains of a leguminous plant, cultivated in India, is used in order to fatten thin and sick people. It is used by cattlebreeders for fattening cattle.

The Arabs use it frequently as an aphrodisiac. It contains mineral phosphates, organic compounds (lecithin and phytin) and nitrogenous compounds.

It must be used as powder from 2 to 3 g before meals. The period of treatment is from one to two months. The weight may increase from 1·5 kg to 4 kg.

From our personal experience we may conclude that fenugreek may be used in the following cases.

(1) In cases of leanness. (Observation.)

(2) For convalescents after serious illness; whatever may be the nature of illness, fenugreek shortens much the period of convalescence and restores the former weight, strength, vigour and energy.

(3) On thin people attacked by diabetes, it combats simultaneously glucosuria, leanness and lack of force and vigour.

(4) For pregnant and thin women and for nursing women whose milk begins to decrease in quality and quantity, fenugreek re-establishes original weight and lactation.

(5) On people who are subject to overstrain, fenugreek works by reinvigorating the nerve-centres with its phosphoric acid and its phytin.

27. The nutritive values of Indian vegetable foodstuffs. Parts I—IV.

S. P. Niyogi, N. Narayana, *and* B. C. Desai, Bombay.

The biological values of the proteins of ten Indian pulses have been determined at a 10 per cent. level of intake by carrying out metabolic experiments on white rats according to the method of Mitchell. The values obtained are:—Dolichos lablab 57 per cent.; Phaseolus acconitifolius 57 per cent.; Lens esculenta 58 per cent.; Phaseolus mungo 60

per cent.; Pisum arvense 62 per cent.; Phaseolus radiatus 64 per cent.; Dolicheos biflorus 67 per cent.; Vigna catjang 72 per cent.; Cajanus indicus 74 per cent.; Cicer areitinum 78 per cent.

The total globulins of the above pulses have been isolated in pure condition and analysed by the Van Slyke method. Arginine tyrosine, tryptophane, and cystine have also been estimated by separate methods.

28. The rationale of the treatment of pulmonary tuberculosis by phrenic exairesis.

M. KESAVA PAI *and* K. VASUDEVA RAO, Madras.

The usual idea that phrenic evulsion benefits only basal cases is erroneous. The diaphragm, though it exerts its major effect on the lower zone of the lung, has a definite influence on the movements of the upper zone also. This has been proved by a careful system of mensuration used on 57 cases of phrenic evulsion, performed in advanced pulmonary tuberculosis. Of these 12 had the disease in the lower zone of whom 5 showed much improvement and 6 some improvement. 27 had the disease in the upper zone of whom 7 showed much improvement and 10 some improvement. In 18 the whole lung was densely involved. Of these 8 showed much improvement and 9 benefited to some extent. By an analysis of the mensuration it was found that there was an average of 10 per cent. collapse at the base of the lung subjected to phrenic evulsion and of 7 per cent. in the upper zone. In the collateral lung there was a compensatory expansion or stretch of the upper zone by 5 per cent. and the lower by 2 per cent. In 23 of the 57 cases a varying degree of sympathetic collapse was observed in the lower zone of the collateral lung. The cause of this collapse has yet to be ascertained. 42 per cent. of the basal cases, 26 per cent. of the apical cases and 44 per cent. with involvement of the whole lung were benefited greatly by phrenic evulsion. Including cases that benefited to some extent, the figures are 92 per cent., 63 per cent., and 94 per cent. in the 3 classes of cases, viz., basal, apical and total involvement respectively.

29. A note on the treatment of pulmonary tuberculosis with sanocrysin in the smaller doses.

M. KESAVA PAI *and* K. VASUDEVA RAO, Madras.

Sanocrysin in the larger doses of 10 to 50 cgr. has given variable results in the hands of different clinicians. The chief disadvantages attending its use especially in hospital work are its rather prohibitive cost and the liability to reactions and complications necessitating stoppage of treatment.

A series of 30 cases of different stages and types treated at the Madras Hospital with smaller doses, viz., ½ cgr. rising to 5 cgr. at intervals of about a week has given promising results, lessening the cost of each treatment more than 13 times and preventing to a considerable extent the occurrence of reactions and complications.

Of the 30 cases 4 were in stage I, 7 in stage II and 19 in stage III. 17 were of the exudative and 13 of the proliferative type. 95% of the exudative and all the proliferative cases benefited by the treatment, compared with 53% exudative and 68% proliferative which benefited with the treatment in larger doses in the case of a series in 1928.

30. On the early pathology of pulmonary tuberculosis,

M. KESAVA PAI, Madras.

A scrutiny of 164 cases of infants and children ranging from birth to 15 years of age has been made at the out-patients' department of the

King Edward VII Memorial Tuberculosis Institute of Madras, the skiagrams of the chest of these children having been carefully examined and attempts made to correlate the appearances and lesions found in them with the results of physical examination, symptoms and history of the cases. It was found that whilst no abnormal appearances could be made out up to the 6th month of life, lesions varying in extent could be seen in the children after the 6th month. These lesions usually increased in number and extent with the age, 14% of children between 6 and 12 months, 20% between 1 and 2 years, 40% between 2 and 5 years, 57% between 5 and 10 years and 60% between 10 and 15 years showing definite and fairly advanced lesions. The presence of signs and symptoms suggesting incipient tuberculosis, the co-existence of cervical glandular enlargement, the presence of a positive Von Pirquet reaction and the fact that the children were mostly residents of the city of Madras where the infection rate is high strongly suggest that incipient pulmonary tuberculosis begins in early infancy and is practically always an extension from the hilus glands.

31. On the age incidence in the morbidity and mortality from tuberculosis in South India.

M. KESAVA PAI, C. A. VENUGOPAUL, MISS P. SAMUEL, *and* B. JAYARAM, Madras.

Morbidity figures have not usually been published on account of the difficulties of early diagnosis in large populations. It has been the custom to obtain approximate morbidity figures by multiplying the mortality figures by a factor, the usual one used being 10. This factor must vary for different age periods, as the acuteness of the lesions and the resistance to the disease vary at the different ages. A morbidity curve for different age periods has been made from the out-patients' register of the Madras Tuberculosis Institute during the years 1916–1930, during which 70,150 patients of all ages were examined and 29,854 were diagnosed as suffering from active tuberculosis. The curve shows the peak in the 20 to 25 year period, but when corrected for age shows the peak in the 15 to 20 year period. The morbidity curve for Madras in the years 1916–1930, the mortality curve for Czeko-Slovakia in 1910, that for England in 1851 and for Sweden in 1911 are all similar to each other having their peaks nearer to 20 years. The curve for mortality in England in 1912, for Australia in 1919–21, and for the United States in 1910–13 all show the height at or after the 30th year. The curves point to the fact that social, hygienic and economic conditions constituting racial resistance were similar in the countries concerned at the periods of time mentioned against each. Countries like India, Czeko-Slovakia, and Sweden appear to be about half a century behind England, Australia and the United States in their hygienic and other factors constituting resistance to tuberculosis.

32. The ultimate results of artificial pneumothorax therapy.

M. KESAVA PAI *and* P. K. GUNASAGARAM, Madras.

584 cases in the III stage of pulmonary tuberculosis were treated with artificial pneumothorax at the Government Tuberculosis Hospital, Madras, during the 7 years 1924–1931. As most of these patients belonged to the lower and illiterate classes it was possible to ascertain the after histories of only 258 of these cases at the end of 6 years. It was found that 75 out of 104 patients who had 6 months or more of the treatment were alive at the end of 6 years, whereas 31 out of 51 who had 3 to 6 months of the treatment were alive at the end of that period. Of 60 persons who had less than 3 months of artificial pneumothorax inflations 33

were alive in 6 years and of 43 controls in whom the induction had failed 26 were alive in 6 years. These results though far less brilliant than the immediate results of artificial pneumothorax therapy compare very favourably with those obtained by the ordinary methods of treatment. In fact they appear better than the results obtained in other institutions, but this apparent superiority is due to the fact that in much more than half the number of the original cases no after histories could be traced, as the majority of persons seeking admission came from the ignorant and illiterate classes.

33. Collapse therapy in the early stages of pulmonary tuberculosis.

P. T. PATEL, Bombay.

A strong plea is made to induce collapse of the affected lung by artificial pneumothorax in the early cases of pulmonary tuberculosis so as to get control of the infection. Much time, money and worry are saved by such a measure for every one concerned with the patient.

A cheap and portable apparatus with a little practice is quite sufficient to carry out the treatment in any average dispensary or hospital in any part of the country. All medical schools should take up this teaching and adopt measures to educate the students in the technique of carrying out this treatment. Also the whole medical profession should be made to realise the benefits of this line of treatment and should be educated in the early diagnosis and treatment of pulmonary tuberculosis by means of post-graduate courses at large hospitals and through the medical press.

34. A study of the blood picture in tuberculous patients in India.

C. FRIMODT-MOLLER *and* R. M. BARTON, Arogyavaram (Madanapalle).

A study of the routine blood differential count (Erlich) carried out on patients in the Union Mission Tuberculosis Sanatorium since 1925, and of the sedimentation test since 1926, and of the Schilling differential count for the last one and a half years has raised the question of the relative value of these tests in pulmonary tuberculosis. The paper deals with :

1. The neutrophile percentage studied with regard to prognosis.
2. Value of the neutrophile count subdivided by the Schilling method studied with regard to prognosis.
3. The relative value of these two leucocyte counts with regard to each other and with regard to the sedimentation test both in relation to prognosis and as a guide for changes in the treatment.

35. Agglutinability of different strains of *B. mallei*.

R. N. NAIK, Muktesar.

Hutyra and Marek (1926) quote Ladany's statement that different strains of *B. mallei* show differences in their agglutinability.

The writer submitted samples of serum from three clinical cases of glanders and two samples from healthy horses to the agglutination test against the antigens of three different strains of *B. mallei* isolated in India from about 1910 to 1930 and has found that there was practically no difference in the agglutinability of the strains.

36. Agglutination reaction due to mallein injections in horses.

R. N. NAIK, Muktesar.

It is not uncommon to obtain a suspicious reaction with the mallein test in a few horses and in such instances one may wish to resort to some serological test, such as the complement fixation or agglutination test, when early confirmation is necessary. But as a sample of serum from a horse recently injected with mallein gives a positive agglutination reaction against the antigen of *B. mallei* the application of the agglutination test in such horses may lead to anomalous results. With a view to find out whether there is any sharp demarcation in the titres of serum from horses infected with glanders and from those injected with mallein and also to ascertain the maximum period during which the serum of a horse injected with mallein gives a positive agglutination reaction certain experiments have been carried out with the following results :—

1. It is almost impossible to differentiate by the agglutination test horses infected with glanders and those recently injected with mallein.
2. The presence of agglutinins induced by an injection of mallein may be found up to about two months.

In order to observe the reaction of the serum of horses repeatedly injected with mallein further studies have been made with the results :—

1. If a healthy horse is subjected to repeated injections of mallein the agglutination reaction simulating that of a positive case of glanders is noticed a week after the first injection.
2. Repeated injections of mallein do not increase the titre above that which is obtained a week after the first injection.
3. The presence of specific agglutinins does not persist longer than a fortnight after the last injection.

37. A simplified method of rapid agglutination test for bacterial diseases. (With practical demonstration).

R. N. NAIK, Muktesar.

A heavy antigen and a glass pipette drawn out into a capillary tube are all that is necessary to carry out the agglutination test of a serum by this method. Required dilution of a serum with an antigen, from 1 in 25 to 1 in 1500 or more, is made in a capillary tube and the results are read off almost instantaneously. The rather cumbersome technique of making dilutions of antiserum and antigen on a glass slide or plate as suggested by Wright (1912) or Huddlesson and Abell (1928) is not required. In practical utility, quickness and the ease with which it can be performed this method stands superior to all those suggested by previous workers and in point of accuracy the results correspond with those of the slow tube method. It is therefore submitted that it is well suited for both busy laboratory and field workers.

38. Agglutinability of homologous and heterologous strains of Brucella organisms during the course of *Br. abortus* (Bang) infection.

R. N. NAIK, Muktesar.

A hill bull was infected with an English strain of *Br. abortus* Bang and its serum was submitted to the agglutination test against the antigen of the same English strain and some Indian strains of the same organism and also an English strain of *Br. melitensis* every two months commencing from the 15th day of infection. As a result one of the Indian strains failed to be agglutinated after the infection had been

running for about two months and it is therefore apparent that an early investigation should be made of all the strains of this organism, which are prevalent in this country, so that the results of the agglutination tests, to which sera from aborted cows are submitted in laboratories in this country may be more reliable.

39. On the value of Wilson and Blair's bismuth sulphite media in the isolation of *B. typhosus* from Faeces and sewage.

A. D. STEWART *and* S. GHOSHAL, Calcutta.

Some general considerations of the media :—

Points that should be attended to in preparation. Observations on the nature of colonies and the time that should elapse before these should be studied. Comparison of results obtained with this method with that of Mckonkey's plates in the isolation of *B. typhosus* from stools. Experience in its isolation from septic tanks both from raw and filtered effluent (before chlorination) and a comparative study of the incidence of *B. typhosus* in these. Study of *B. typhosus* in the activated sludge process. Differences in the two processes of purification. Incidence of *B. typhosus* in Calcutta sewage. Experience during monsoon and the cold weather. Remarks on the value of the media.

40. Bacteriophagy and Twort's phenomenon.

S. V. DESAI.

The behaviour of the bacteriophage from the root nodules of the leguminous plants for the corresponding organisms sheds a new light on the controversy of these phenomena being identical. These bacteriophages give a modified form of Twort's phenomena. Granules staining reddish by Giemsa stain as well as by Borrel's stain have been observed. The dissolution of the organisms in colonies on solid media has been established. The dissolution of the organisms in liquid cultures and the plaque formation on solid media have been observed with the same bacteriophage. two types of plaques have been observed according to the type of growth of organisms and the previous history of the bacteriophage and it has been suggested that Twort's phenomenon is nothing but a manifestation of a bacteriophage which has the property of spreading into the cultures of the organisms on solid media, the action of the bacteriophage not being inhibited by the presence of the products of bacterial dissolution and that an unnecessary stress has been placed on the formation of bacterial fragmentations and granules staining reddish with Giemsa.

41. A note on the antigenic structure of secondary cultures obtained with the 3 types of cholera phages and a strain of cholera vibrio.

C. G. PANDIT *and* R. SANJIVA RAO, Guindy.

The antigenic characters of the three types of secondary cultures were studied. The main change was in respect of the presence of the somatic antigen. This was considerably diminished in the case of secondary *A* but it persisted in varying amount with secondaries *B* and *C*. The above gradation was noted in the case of flagellar antigen also. The power to provoke normal agglutinins was found to be proportional to the amount of somatic antigen present. The results are in accordance with the difference in behaviour noted with the three types of cholera phages. The rough variant produced independently of any phage action, showed more or less the same antigenic structure as was noted with the '*A*' type of secondary culture.

42. Auto-proteose from urine as a therapeutic agent in disease.

T. SITHAPATHI IYER, Guindy.

As found by Oriel and Barber in Allergic and anaphylactic conditions a protein-allied product is excreted in more than normal quantities in the urine. The substance thus excreted, usually called Proteose, has been found by experiment to possess the property of raising skin reactions on patients when used as a desensitising agent in the above mentioned conditions. The substance is a precipitate from urine obtained by treating urine with ether and alcohol, soluble in caustic soda solution. Dilutions of the solution are injected intradermally.

The Proteose treatment was tried in cases of asthma, psoriasis, dermatitis and urticaria. It has been found so far to yield great benefit to psoriasis and urticaria and some alleviation of the acute symptoms in asthma and dermatitis.

Section of Anthropology.

President:—J. P. Mills, Esq., M A., I.C.S., F.A.S.B.

Presidential Address.

Anthropology in the India of the Future.

Gentlemen,

First I wish to thank you for the great honour you have done me in selecting me as President of your Section this year. I had naturally hoped to have the pleasure and privilege of addressing you in person, and it is a great disappointment to me that this cannot be. Work is very heavy nowadays and it was not possible to grant me leave to come this great distance to meet you. My brief address is very kindly being read to you.

All eyes are turned to the future, and it is on the future that I wish to speak to you to-day. We do not yet know what the Round Table Conference will evolve, but whatever changes may come, and whatever constitution may be planned, a great task lies before anthropologists in this vast country. It therefore seemed to me right and natural to attempt to bring to your notice this year some aspects of that task and some suggestions of the allies we ought to call to our aid. It is one which will tax all our energies. I can think of no science which has before it a future of such activity and usefulness as anthropology. It is our almost unbelievably good fortune that the need for anthropologists in India comes at a moment when the science has reached a point of practical efficiency it has never before attained. To-day I want to try to put before you some thoughts on the wide scope of modern anthropology, some indications as to why India needs the services of the science for the solution of her problems, and some suggestions as to the practical ways in which that need can be met.

The Oxford Dictionary defines anthropology as 'the whole science of man'. For many, many years it meant in practice far less than this. We began with descriptions of wild tribes that were little more than travellers' tales, in which the curious was emphasised at the expense of the normal. In their own countries anthropologists were hard to distinguish from those persons vaguely termed 'antiquaries'. Much of their excavation was without method, and much valuable evidence has been lost for ever. Even in modern times anthropology has often been denied its full

scope. As recently as 1926 Max Schmidt in his *Primitive Races of Mankind* says 'Ethnology is the study of the voluntary manifestations of human life outside the zones of Asiatic and European civilization'. He retains the term 'anthropology' for the physical side of the science only. Modern science has said with no uncertain voice that definitions of this kind will not do. Most people nowadays would use the term anthropology in a far wider sense and would include ethnology within it. Nor would they by any means confine its scope to the study of the more primitive races. Glancing through the list of the most recent acquisitions to the library of the Royal Anthropological Institute I find books on the following subjects—sociology, folk-lore, language, travels, history, archæology, religion, magic, chronology, descriptions of primitive races, classical studies, psychology. games, art, agriculture, economics, evolution, land tenure, morphology, technology, heredity, physiology, biology and palæontology. Even this long list could be greatly extended by a scrutiny of the books added during the last two or three years. In that most useful book, *Notes and Queries on Anthropology*, published by the Royal Anthropological Institute suggestions are made regarding the aspects of the life of any one people which must be studied before a complete anthropological record can be obtained. In the 5th edition the following are among the headings—physical anthropology, cultural anthropology, sociology, social groups, life history of the individual, economic life, regulation of public life, political institutions, law and justice, warfare, psychology, religion and magic, material culture, technology, personal ornaments, clothing, habitations, food, stimulants and narcotics, utensils and weapons of every kind.

What are we to infer from these long lists of subjects and headings? Firstly, surely, that there is no part of human life with which anthropology is not concerned, and that the Oxford Dictionary's definition of it as 'the whole science of man' is no idle boast. Secondly that it is not only a descriptive, but also an applied, science. Thirdly that we must give up the attempt to draw a hard and fast line between physical and social anthropology. True it is that on the physical side we can study man's body, and the effects thereon of his diseases, drugs, diet, medicines and so on. But these very things are conditioned by his environment, and the use he makes of his environment is conditioned by his mental and social life. These again react on his environment, and so on in an endless circle. In short we can no longer attempt to divide our science into water-tight compartments, and we can sum up its scope by saying that it is the study of the interaction of man and his environment. Now this study is no mere pleasant pastime. It is something that *matters*—

something that matters to ourselves and all whom we try to guide or advise. It is an applied science. This is the chief point I want to try and emphasise to-day.

Why exactly is anthropology an applied science? It is because we are not studying something static. The astronomer with his telescope and his mathematical tables is observing something which is changing, it is true, but changing so slowly that the process is of little practical importance and in any case cannot be altered or controlled. Not so the anthropologist. Man's environment, social and physical, is always changing, and with it man's reactions. The task of the anthropologist is to study these reactions, to foresee what changes a particular alteration in environment is likely to bring about, and, armed with comprehensive knowledge, by his advice to the administrator, to attempt to guide changes and reactions to the common weal. It is an axiom that an applied science only comes into being in response to a demand. Modern anthropology has arisen as an applied science. We are bound to ask why. The logical answer is that modern changes in man's environment have summoned it. We are again bound to ask the cause and nature of those changes. Two things above all seem to have brought them about—the war, and the recent amazing advance in mechanical knowledge. In August 1914 there began a struggle such as the human race had never known before. Wars there had been from before the beginnings of history, but they had been local. Never before had there been a war which left no quarter of the globe untouched. For the first time since man appeared on the earth the whole human race was in agony together, an agony which will leave its mark for ever. Man fought in the steamy forests of Africa, on the frozen tundras of Russia, on the stormy seas of the Antarctic, in the grey mists of the north, and on the age-old battle-fields of Europe. Papua and Alaska felt the call. From India's plains, from the jungle-clad hills of Assam, from the deserts of Arabia, from the Maori villages of New Zealand, from the remotest kraals of Africa men came to the fight. None went back as they came. All felt that the very foundations of life had been shaken and the whisper of questions was heard throughout the world. The very assumptions on which civilization is founded are no longer accepted without question. An antagonism has even arisen between the family and the state. Human life as we know it is founded on the family, but Fascism at one extreme and Bolshevism at the other say that the first loyalty of a man is to the state. Man's environment has been changed by the war, but far more has his attitude towards his environment, and hence his reactions. A world-wide change has come. It is for anthropologists to study that change and if possible to soften its harshness and to guide its course.

Opening Proceedings.

The nineteenth session of the Indian Science Congress was opened on Saturday, January 2nd, 1932, at 6 P.M. by Sir Mirza Mahomed Ismail, C.B.E., C.I.E., Dewan of Mysore, at the Intermediate College Hall, Bangalore, in the presence of a large gathering of delegates and visitors.

Before the opening of the Congress by the Dewan of Mysore, the Chairman of the Local Reception Committee, Dr. E. P. Metcalfe, welcomed the delegates in a short speech, and requested Sir Mirza Ismail to communicate the gracious Message of the Patron, His Highness the Maharaja of Mysore, and to open the Session, as follows:—

'SIR MIRZA ISMAIL, PROFESSOR KASHYAP, LADIES AND GENTLEMEN,

It is my pleasant duty, on behalf of the Local Reception Committee, to extend to the Indian Science Congress a very hearty welcome to Bangalore.

The Science Congress is no stranger to this City, having already held two very successful Sessions here. I venture to believe that this locality provides an atmosphere which should be congenial to scientific workers. Here, and in the immediate neighbourhood, are located the Science College of the University of Mysore, the Indian Institute of Science and the scientific departments of the Government of Mysore, all of which foster the spirit of research and original investigation. Within easy reach are many objects and institutions of interest to the scientifically minded, which should be visited as opportunities occur. Facilities for visiting and inspecting some of these are being provided; and it is hoped that many of you will take advantage of them.

We trust that our arrangements for your convenience will generally meet with your approval; and that you will be good enough to excuse any deficiencies in this respect, for even the best laid plans are apt to miscarry at times. But I am hopeful that any such will be few and minor, since the local secretaries and those actively associated with them in the preliminary work of preparation have regarded their responsibilities very seriously, taking the greatest pains to ensure, so far as it may be possible to do so, smooth running in all departments.

I offer you, then, our best wishes for fruitful and inspiring discussions at all your sectional meetings, that these may result in further stimulating and encouraging research during the year that is before us; and I venture-

After the war has come an advance in mechanical knowledge so swift that it takes our breath away. Certain it is that it has gone far beyond our civilization. Skill has outdistanced wisdom, and there is grave danger that man may misuse his own inventions. The exact relation, which must exist, between the upheaval of the war and this breathless mechanical advance still awaits study. That the advance has been made is enough for our theme to-day. Wireless encircles the globe, and the words of an announcer in England can be heard in India. Conversations across the Atlantic by wireless telephone are becoming common matters of routine, and television is bound to be perfected soon. Aeroplanes can fly at 400 miles an hour, and seas, mountains and deserts are no obstacles to them. The world is far smaller and more closely knit than it ever was before, and any movement of importance leaves no part of it unaffected.

No country has felt the change more than India. Consider the increase in transport. Compare the number of 'buses and cars on the roads with the number we saw only ten short years ago. They penetrate the remotest villages and the peasant can easily and cheaply accomplish in a day a journey which formerly he never contemplated. He can be brought to centres where new ideas are seething, and new ideas can be brought to him through newspapers which can now be printed and transported more swiftly than ever before, and which more and more people can read. Thus contact with the world of thought and ideas can be had by all who desire it. More revolutionary still, it is forced on those who do not desire it. The shy jungle and hill tribes are being driven further and further back into their dwindling fastnesses. Skill in combating disease and transport which makes famines impossible have led to an increase in population which is absolutely terrifying. More and more land is being taken up as the pressure becomes greater. Roads and railways are being made where there were hardly paths before. Surveyors and geologists seek oil and minerals in the remotest corners of the peninsular. Everywhere there is closer contact and, of necessity, the change that closer contact brings about.

It is to meet this change that anthropologists in India must mobilize their forces. To that wise man Robert Louis Stevenson we owe the dictum 'change is bloodier than a bombardment'. By change he means uncontrolled change. It is most certainly true. He was living in the South Sea Islands and saw fine races wilting and dying under the impact of civilization. All over the world it is the same. There are the detribalised Bantus of South Africa, discontented with the culture they can never make their own. In America a mere remnant of the aboriginals remains, too feeble to contribute anything to the common good. There are many nation-

alities in India who will suffer unless wise councils prevail. In this continent are some of the highest and some of the lowest cultures of the world. All are now in contact with one another as they never were before. Human nature being what it is, contact means competition, and competition, unless controlled, means strife. Strife if sufficiently prolonged means extinction for one of the parties, and we can afford to lose no culture, however humble or however local. Every culture is the fruit of human experience in the past and has something to contribute to human life in the future. We may not be able to see now what that contribution is, but let us beware lest we find later that we need something we have allowed to pass beyond recall.

Change we cannot stop. But we can guide it, and this is the duty of anthropologists. Our aim must be to see that, as far as is humanly possible, all benefit and none suffer from change. Thus all will be strengthened, and made readier to contribute their quota, be it great or small, to the good of India. Our first duty is to study our problem, for from knowledge alone can right action spring. Here every profession can aid us, provided—and this is an important proviso—they come to their task with open minds, ready to use the past but refusing to be bound by it. So important is it that these contributions should be made that I wish to make a few concrete suggestions on the aid various professions and branches of learning might give. The order in which I take them is entirely haphazard. So important is the contribution each can make to the knowledge of mankind that I cannot put one before the other.

Law has attracted some of the most brilliant brains in India and lawyers can help us greatly. Let us be quite frank. We have lived for years under written codes upon which the rulings of High Courts have accumulated thickly. Many in their heart of hearts have long felt that the system of one fixed, elaborate, written law for the whole of India is breaking down. Cases drag on for months or even years, and delay and expense themselves defeat the justice which the law was evolved to obtain. Deep in the country is a strong feeling that the day of this cumbersome system is over, and that feeling will inevitably become vocal. Also deep down, hidden but not lost or forgotten, are many systems of customary law. In the most intimate things of life, and where religion is concerned, customary law still operates. The day may come when it will operate in ordinary dealings. There are inherent in it virtues which the codes cannot have. It was never imposed from without, but was evolved from within; it has been made and moulded to fit the environment in which it is to be used, and no artificial law can fit that environment half as well. Its importance is now fully realised and a bureau for

its study has been opened in Paris. I do urge that skilled lawyers all over India should examine the systems of customary law obtaining near their homes and reduce them to writing. Thus there will grow up a *corpus* of true indigenous Indian law.

Physicians too must come to our aid. There is an immense store of accumulated knowledge in the indigenous medical systems of India. That knowledge must be classified and made available for study. Besides the well-known systems there are hundreds of lesser known, simpler ones in use among primitive folk. Jungle tribes have for unknown ages used various herbs and benefited thereby. It is for physicians to study the exact effects of those herbs, for botanists to name them, and for chemists to analyse them and tell us the drugs they contain. The physiologist, with his study of living tissues must also come to the aid of the physicians. The problems before him are of the utmost importance. Why, for instance, does the incidence of leprosy seem to increase with certain diets? Why is yaws so closely connected with the Negroid race that the existence of the disease in certain races has been taken to prove the presence of Negroid blood? Is the diet of the common people of any locality as well balanced as their means and their environment permit?

Closely allied to the physician is the anatomist. Here splendid work is being done, as papers to be read this year, and those of former years show. But those who have laboured hardest in this field would be the first to tell you how much remains to be accomplished. Without the anatomist we can never write a full racial history, and without such a history our view of any race lacks background and perspective.

This brings us to the essential part of the historian and the archæologist must play. It is hard to distinguish them. Year by year the historian goes further and further back, absorbing the work of the archæologist, while the archæologist in turn delves further and further into the ages before men knew the use of metal. Nowhere has the recent advance of Indian anthropology been greater than in this department. The wonderful culture of the Indus has been almost, if not quite, brought within the confines of history, and the time will inevitably come when it will be linked both with the past and the present, and our Indian history books will have to be rewritten once more. Work is being done too on the immense stone age deposits of the continent. Here yet another scientist, the geologist, has to be called in. He alone can tell us the relative ages of strata and so help us to link the ancient stone cultures of India with those of other countries.

There would seem to be three main sources of

history, written records, the remains of the past, often only to be brought to light by the excavator, and last, but by no means least, myths and legends. Here we involve the aid of the mythologist. His field is great and his task is an urgent one. No country has a greater wealth of legend than India, but we are in danger of losing it. The younger generation no longer listens to the tales of the old men, and a priceless heritage may pass away for ever. All myths and legends, without exception, deserve to be recorded with scrupulous care. They originate from that Golden Age when man's memory was not yet weakened by the knowledge of writing and in them are embedded real pieces of history. A myth does not grow from nothing in the brain of man. Something gives rise to it, and it is the business of the mythologist, by careful comparative study, to find out what that something is. Now the unintelligent recording of myths is dangerously easy, and I would ask my hearers to convey a warning to all untrained assistants in that field. There are two wrong ways of taking a myth. One is to adopt an attitude of supercilious superiority and the other is to swallow it whole. No one with any pretensions to being an anthropologist is likely to commit the first error; were that his attitude he would not trouble to listen to the myth at all. The other error is dangerously common however. This I say from my own experience. Students of lower castes, working hard on the history of those castes, have brought to me results entirely vitiated by wholesale acceptance as history of obviously late legends. The history of lower castes is of the greatest interest and importance. We know that they were in India before Hinduism came to the country, and to represent them in all seriousness as Brahmins who have fallen on hard times, so to speak, does not help science. What we want are the myths which are older than the stories of the Hindu Pantheon. It is from them that we may hope to glean scraps of the very earliest history of the caste or tribe.

Now for a moment I want to turn to another science, psychology. Immense though its literature is we do not yet know its limits and it is still in its infancy. Psychology, like charity, begins at home, and it was the mind of civilized man which was first studied.

More lately work has been done on the mental processes of those at the lower stages of culture. Nor is the waking mind of man alone studied. The subconscious ranges free during sleep and dreams and the interpretations put on them are a fertile and hardly touched field of study. We anthropologists cannot do without the help of psychology however cultured or however rude the race we may be studying at the moment. There has been neglect in the past, it cannot be denied. But man's life can be said to be conditioned by the

interaction between his mental processes and his environment, and it would be fatal to neglect the first and concentrate only on the second. In nothing is the mentality of a race so clearly shown as in its music, painting, sculpture and other arts. Here the musician and artist must help us. The musician who is to co-operate with the anthropologist in India has a difficult and highly technical task before him that he only can do. While the main systems of music have been studied there are systems among primitive tribes for which no system of notation even has been devised by which they can be recorded. There is a real danger that some of them may be lost, and we can afford to lose nothing. Tribes which are Hinduised tend to adopt Hindu music, and where Christian missions have made progress European tunes are nearly always substituted for local ones, largely because the missionaries, with the best will in the world, have not the technical knowledge required to record and adopt the music they find on their arrival. The arts of drawing, painting and sculpture too have been sadly neglected. There is a book by Mr. Henry Balfour on the evolution of decorative art. It is of the greatest interest but as far as I know it is the only one of its kind. Art is no more static than any other part of human life, and such things as designs change rapidly, though each generation may think they are faithfully copying the work of the one before. To show how rapidly and how easy this change may be I want to digress for a moment in order to mention an experiment given by Mr. Balfour. Any of you may try it. Let him draw some simple design, say a snail crawling over a stick. Then without saying what it is meant to be, let him give it to some friend, who is not a professional artist. Let that friend copy it, and give his copy to a second friend, who will make and hand on a copy in turn. If this is done 20 times, each copy being made from a copy, I will guarantee that you will have a picture of something quite different at the end. This process of unconscious alteration is happening all round us and the results are of the greatest interest. One tribe in the Naga Hills is very fond of a handsome *fleur de lys* design for decorative purposes. Dr. Hutton and I have been able to show, by existing examples illustrating every stage of the process, that this design is derived from the ears of *bos frontalis*, an animal whose head is portrayed in more or less conventionalised carving everywhere throughout the area.

Carving brings me to technology, an essential part of anthropology. By it I mean the science of the material arts and crafts of man,—his utensils, tools, weapons, musical instruments, clothing, ornaments and so on. At first sight this would seem to be little more than a pleasant hobby, leading us nowhere. This is not so. It is of supreme im-

portance for the study of the history and migrations of races. The geographer must come to our aid if we are to get the results we require. The method is this. You take the distribution of, say, the sawthong for making fire and plot it on a map. Then you take something else, say the thorn-lined fish trap, and so on. When you find that the plotting of four or five distinctive things covers the same line on the surface of the globe you know that the races inhabiting that line have something in common, and that your map shows either a line of migration or a line of communication and distribution. For the proper study of this in India we want a museum on the lines of the Pitt-Rivers Museum in Oxford. There you do not have one case allotted to one country, but one case allotted to one thing, be it looms, cross-bows, flutes, fire-making appliances or whatever you wish. Each specimen being fully labelled you can study both the evolution and distribution of any article. The results are of absorbing interest.

In questions of distribution the philologist, and with him the classicist, must have his say. They are specialists who stand rather apart from the other scientists we have asked to join us. Their output has been enormous and of the greatest importance, but there are still vast untouched fields, and I have a feeling that they will have to call in the psychologist to help them. Language is a mysterious thing, perhaps because it is the most essentially human thing we possess. In some respects it seems so static, and in others so fluid and easily adopted. To leave together in a room two scientists who held opposite views as to its value as evidence of racial affinity might lead to culpable homicide, though not to murder, as the killer would certainly be able to plead grave and sudden provocation.

The economics and indigenous political systems of communities deserve special study by trained students, but I must hasten to the end of my list lest I weary you. The educationalist must, however, be considered for a moment, for on him the future of each rising generation largely depends, and his services are essential to our work. Quite apart from schools or colleges every community in India has its system of education in the home, where the real foundations of character are laid. It is common enough to hear these systems discussed when some trait is being criticised. Boys are perhaps said not to be truthful in some community because they are not taught the value of truth from their earliest years. But my plea is that good traits should be studied too. For instance in some races one finds a wonderfully balanced sex feeling, free alike from indulgence and undue repression. The root causes of this can only be learnt from the earliest prattle of children, and there is wonderful work awaiting men, and even more women, who will gain the confidence of various communities

and study in detail the upbringing of their children from the cradle onwards.

I could extend almost indefinitely this list of scientists who can help us, but the address is already becoming over long. You naturally ask where there is a place for the anthropologist himself. Has his work been divided up till there is nothing left? Far from it. It is he who must collect and collate the results he wants from all these branches of study. No one man can possibly be master of them all. With this assistance behind him let us see if it is possible to outline the precise work of the anthropologist in India in the future. It seems to fall into three departments, not independent, but co-operating. The archæological anthropologist, calling to his aid those branches of science which can help him, will give us our true historical perspective. He will tell us what the conditions were in the past and aid us to link those conditions to the present. With him is his ally, the physical anthropologist, ready to study the human remains of the past and connect them with the races of to-day. The present life of those races is the study of the social anthropologist, who can make use of the work of a score of specialists if they will only help him. Intensive observation must precede the extensive and synoptic. The simple must be studied before the complicated. That is why a sound instinct has led anthropologists all over the world to pay special attention to primitive races. This must be our rule in India too. We must study the beliefs and morality of the more backward communities sympathetically in terms of their own thought, and without desire of substitution. We must know every detail of their mode of life. Only so can we hope to understand them and give that guidance in these days of change which will tend to preserve all that is best in each of the many races of this land. Nor does our work stop with the humbler races, specially great though our responsibilities are towards them. As we all know the great communities of India have their differences. When we call a difference of this kind a misunderstanding we are using no mere figure of speech. We are going to the very root of the matter. In knowledge and understanding, and in yet more knowledge and understanding lies the cure of these differences. Our science is the whole knowledge of man, and to omit highly cultured races from its scope would be to stultify it.

India must come into line with other countries in recognizing that anthropology is no mere pleasant hobby. There will, I hope, in the future be a trained anthropologist attached to every province and State in this land. As an example of what has been done elsewhere let me quote the Gold Coast, on which Professor John L. Myres has recently touched in his presidential address to the Royal Anthropological Insti-

tute. Captain R. S. Rattray has long been official anthropologist to the colony. It is now proposed to give selected officers, who volunteer and are enthusiasts in the science, special study leave. These officers will then be required to report on some piece of important anthropological research in their districts. The best will then be given further intensive training for six months. It is not intended at present to appoint a successor to Captain Rattray, leaving the anthropological work in the hands of a number of specially trained officers. But Professor Myres anticipates, and he is certainly right, that a man will soon be required at headquarters to deal with the immense amount of valuable material that will be concentrated there.

It is something of this kind that we should like to see in India. Anthropologists are primarily advisers. It is not their business to submit policies to the administration. But once a policy has been stated by an administration it will be the duty of the anthropologist to say without bias what its effect will be, especially on humble communities who have a small voice, or no voice at all, in the conduct of affairs. No one else can perform this duty. A primitive race might produce one or two educated men, but it is often found that such men are entirely out of sympathy with those they have left behind.

My address has dealt entirely with the future. Anthropology, fortunately for us, is advancing and developing just at the time when India's needs are greatest. It is now an applied science embracing every part of human life. Changes have come on us such as no former generation has known. India asks for our help and guidance in those changes and we must give it. And we in turn have the right to demand assistance from other branches of science. Our method must be to move from intensive study to extensive, and primitive races are both our best field for intensive study and most in need of the help that sympathetic knowledge can give. While the humbler races must be our first objects of study and our first care, our duties extend far beyond them to the highest. Every country is awakening to the practical value of our special branch of learning, and we ask the Government of India to use us.

And now I must close. You will be eager to listen to the brilliant papers that are being presented to you. Once more I must express my regret at not being able to be present myself. I hope this session will be successful in every way and that our added knowledge of the splendid work that is being done will give us encouragement for the strenuous future before us.

Section of Anthropology.

Abstracts.

1. An account of the Sedentary Game *Suhia*.

HEM CH. DAS-GUPTA, Calcutta.

A description of the game.

2. Some northern seals and crests.

J. C. DE, Colombo.

The period under review extends from the fourth to the tenth century A.D. Seals may contain figures and writing. These figures sometimes indicate cognisances of ruling houses. On the sceptre type (called also the spear or standard type) of Samudragupta's coins, e.g., we find the Garuḍa. The Garuḍa also figures in Gupta charters and the Bhitari seal of Kumāragupta. The crescent which can be found on some of the coins probably refers to the name of Candragupta (candra = moon). The Bird appears with outspread wings, stands on an altar, is represented with human arms holding a snake, or with a man's face, a wig like that of an English judge on his head, and a snake twined round his neck. The seal of the forged Gayā grant of Samudragupta is probably genuine. In this, the Garuḍa is figured as a bird with outstretched wings. The Garuḍa may well be taken as the imperial crest. We may compare the Roman and Napoleonic eagles.

The Uccakalpa seals 'contain in relief on a countersunk surface at the top, Garuḍa' 'with outstretched wings just as on the copper coins of Candragupta II'. Mahārāja Jayanātha was possibly a vassal of the Imperial Guptas.

The seal of Hastin of the House of Nṛpatiparivrājakas, a neighbour of the Uccakalpa rulers, was oval in shape and may have contained the inscription Srī-Mahārāja-Hastinaḥ.

The author examined the seal of Sārvvavarmman of the Maukhari House in the India Office. In the top portion of an oval field there is a bull with an umbrella decked with pennons. One man precedes the bull and the other follows him. Both of them have axes in their hands. A standard surmounted by a wheel (and pennons) and a cāmara are also carried. The bull was probably the crest of the śaiva monarch in the same way as the Garuḍa was of the Guptas. A seal of Dadda II of the Gurjaras contains 'Śrī Dada' and 'a square emblem the character of which is not clear'.

The family crest of Vishṇuvardhana is definitely the aulikara (= the sun?). The oval Maitraka seal has a recumbent bull in one compartment and 'Śrī Bhaṭakka' (or Śrī-Bhaṭārkka) in the other. Two horizontal lines divide these. The seal of the first known predecessor of the Imperial Guptas is oval in shape, and contains the legend 'Gutasya'.

P. M. P. Jayādityadeva of the Malayaketu House issued a copper plate on the top of which there is an oval projection containing 'a full blown lotus, the centre of which consists of a raised disc bearing the image of some animal, perhaps a boar with Śrī-Jayādityadeva written below in raised characters'. The seal of Vainyagupta (a distant scion of the Gupta House?) is soldered on to the śāsana, oval in shape and separated by two horizontal lines in the middle. It contains 'a bull recumbent to the proper right' and probably the name of the Mahārāja.

to express the hope that, your labours completed, you will carry away with you a pleasant memory of the Bangalore Session of 1932.

I now request Sir Mirza Ismail to communicate the gracious Message of our Patron, His Highness the Maharaja of Mysore, and to open the Session.'

After the speech of welcome by the Chairman of the Local Reception Committee, Sir Mirza Ismail opened the Congress by reading the following gracious Message from His Highness the Maharaja of Mysore:—

'It is with very great pleasure that I welcome to Bangalore a distinguished body of scientific men, representative of the Universities and learned bodies of the whole of India. And I hope I may take it as a compliment, not only to the salubrious climate in which you meet, but also to the spirit of enquiry and research that has been engendered, by the Mysore University as well as by the Indian Institute of Science, that you have chosen Bangalore for the third time as the place of your meeting.

Scientific research is making very rapid strides in India, as in the rest of the world, and this is to be attributed in no small measure to the inspiring influence and co-ordinating effect of your meetings. My only doubt is whether you do not need to hold many more of them. Science is remaking the world, and the obligations that have been laid on birth and wealth in their turn now fall to be shared by Science as well.

One of those obligations seems to me to be to do what mortals can to keep the different processes of the remaking in touch and tune with one another. Such co-ordination seems to be sadly lacking at present. You give the world speed, and there is a death-roll like that of many battles. You mitigate disease, and the incapables increase and multiply. You discover new explosives, and place whole populations at the mercy of misguided individuals.

It may be said that it is an impossible task to develop the minds, the senses and the moral faculties of men so as to enable them to cope at once with the conditions that accrue from new discoveries in the field of physical science. But co-ordination can at least do something, and I commend to you the idea that you should do what in you lies to help the world to treat the Book of Knowledge as a whole, and should take one another into council as to the reactions of new discoveries in one branch of science upon the conditions that are dealt with by the others.

The Devapatanam Stone Inscription of Aṁsuvarman and the Katmuṇḍu Inscription of Śivadeva of the Ṭhākuris have on their tops reclining bulls. The clay seal of Mahārāja Pushyeṇa bears 'a rude impression of the sun and moon and an inscription in four lines'. The seal of the Rāshṭrakuṭas of Ankulesvar contains a figure of Śiva 'holding two snakes'. Neṭṭabhañja of the Bhañja family had on his seal 'a lion in the squatting posture with the head hung down facing to the right'. The Kāmavana inscription of Vatsadāman has on its top a cakra or wheel. The seal of Subhākaradeva of the Bhauma House contains the name of the ruler, and 'a couchant bull facing to the left'. Surmounting these 'there are a crescent and a conch'. His banner was emblazoned with a lion or lions. The legends on the circular seals attached to the three Faridpur Grants of Gopacandra and Dharmmāditya are probably identical (Vāraka-maṇḍala-vishay-ādhikaraṇasya). There is a female figure in two of them, but the details probably differ. The emblem on the remaining one is corroded. Calukyas of the Mānavyasa (?) House had the Boar ('obtained by favour of Nārāyaṇa') as the crest. The Sonpat copper seal of Harsha (of the Varddhana House) has 'a bull recumbent to the proper right', and several lines of writing.

Seals are generally oval or circular, have a religious significance and are used to authorise grants. Sometimes they bear emblems which are not family crests.

3. Ethnic Types in Eastern India.

H. C. CHAKLADAR, Calcutta.

By a combination of the Cephalic and Nasal Indices the peoples of Bengal and Assam are divided into four groups—viz., (1) Brachycephalic Leptorrhine, and (2) Dolichocephalic Leptorrhine, that is, the two types of *Homo Indo-Europaeus*, brachymorphous and dolichomorphous or, Pamirian and Indo-Afghan respectively, and besides, (3) Dolichocephalic Platyrrhine (i.e., Pre-Dravidian), and (4) brachycephalic platyrrhine (i.e., Mongoloid). The analysis is based upon the following measurements: Risley's measurements of the castes and tribes of Bengal; H. C. Chakladar's measurements of the Maithil, Bhumihar and Bengal Brahmins; measurements of some castes of Bengal by Mr. T. Roy-Chaudhuri of the Anthropology Department of the Calcutta University; measurements of Calcutta college students by the Students' Welfare Department of the Calcutta University; measurements of Khasis by the Anthropology Department of the Calcutta University; measurements of Abors by J. Coggin Brown and S. W. Kemp; Waddell's measurements of the tribes of the Brahmaputra Valley.

4. A revision of Risley's anthropometric data: Part II. Castes and Tribes of Chittagong.

P. C. MAHALANOBIS, Calcutta.

The revision of Risley's data Part I (*Bengal Castes and Tribes*) was presented before Indian Science Congress in 1931. In the present paper this work is extended to cover the Chittagong data. All individual figures for both measurements and indices have been scrutinized, and revised mean values have been constructed. It is believed that with such revision the data may now be used for scientific analysis.

5. The Maha Makham or Great Sacrifice.

L. K. ANANTHAKRISHNA IYER, Calcutta.

Its origin, tradition and history. Its termination.

6. Ordeals.

L. K. Ananthakrishna Iyer, Calcutta.

The chief forms of ordeals recognised by the Hindus in ancient times. Their survivals during later times. Their abolition.

7. The Chenchus.

G. Ahmed Khan, Hyderabad (Deccan).

Origin.—They claim to be a non-Dravidian tribe originally inhabiting the woods below the Ghats and belonging to one of the seven forest tribes. Their ancestor had seven sons and a daughter. The latter bore a son for Krishna.

Habitation.—They are found in hills along the Kistna, forming the southern boundary of the Hyderabad State.

Physical Features.—Their physical aspects vary from Australoid and Negroid to Dravidian and Aryan types.

Houses.—Their houses, conical in shape, are built of grass thatches, standing on a circular bamboo matting. The entrance is protected by a bamboo mat door. The houses are equipped with a few earthen cooking utensils and bamboo baskets for storing provision.

Food.—They subsist on such forest produces as they could get, notwithstanding rigid forest regulations. Their principal article of diet is tamarind fruit eaten mixed with the ashes of the bark of the tamarind tree. Honey and fruits are also eaten.

Dress.—The men's dress consists of a strip of cloth passed between the thighs and held to the waist by a string, the ends of the cloth hanging both in front and back. Some have an additional piece of cloth, about two yards in length, on their shoulders.

Women are likewise scantily clad.

Language.—They speak Telugu with a peculiar intonation.

Sub-divisions.—They have four endogamous groups (1) Telugu, (2) Ādavi, (3) Krishnā, and (4) Bontā.

Their exogamous groups number ten, based on totemistic and territorial considerations.

Marriage.—Free courtship prevails among young people and marriage is invariably after the age of puberty. Polygamy and widow marriage permitted.

Religion.—The Chenchus are animistic in religion and believe in the influence of evil spirits. The chief of the clan is the priest at all social and religious functions and rites.

Lingam, represented by a piece of stone, placed under a tree is worshipped.

Disposal of the Dead.—They bury their dead, each family having its own cemetery. Over the grave, stones are heaped.

Contact with civilisation.—The Chenchus are by no means free from contact with civilised communities. Their present mode of dress, wearing of hair and use of razors by men for shaving beards, are evidence of slow process of civilisation.

8. Observations on some oblique-shaped Indian Skulls.

B. N. Datta, Calcutta.

A craniometric study of twelve oblique-shaped Indian crania of the Calcutta Museum is made. Nine belong to male and three to female sexes. Martin's method of measurement is followed.

Regarding the skull index eight are dolichoid, four are brachycranials. As regards Nasal indices three are leptorrhiniens, three are mesorrhiniens, and six are chamaerrhiniens. In matters of facial profile and nasal profile angles all are orthognathous; hyperorthognathie is more prevalent.

Amongst physical *characteristics a dolichoid-Chamaerrhinien-hyper-orthognathic* element is dominant.

The craniological study of these skulls shows that six contain wormian bones in sutures; eight have prodentile; one contains Inca bone; superciliary ridges exist in four; two skulls have highly serrated sutures. All skulls are oblique shaped.

The oblique form is of two varieties—in one form, the left parietal bone protrudes out towards the occiput, conversely the right-side frontal bone of forehead bulges out; in other form, right-parietal and occipital regions protrude out at the back; while left frontal-metopic bone bulges out in the front.

These skull-forms cannot belong to particular racial types; neither these are artificially deformed nor originated by carrying loads on the head. Explanation is to be sought in biological factors. An obliquely deformed skull is called Plagiocephalus. Its descriptions agree with the skulls examined here. Hence it may be said, these are plagiocephalic skulls.

9. Anthropometry of twenty South Indian Skulls.

A. Ananthanarayana Aiyer, Madras.

The craniometric measurements of twenty South Indian skulls of known data, available in the Anatomy department, Medical College, Madras, are made. Appendix (1) gives in tabular form details regarding age, sex, community and district (Linguistic) of skull.

Appendix (2) gives the tabulated measurements.

10. Rock-cut Cave-tombs at Feroke, South Malabar.

A. Aiyappan, Madras.

(Communicated by Dr. F. H. Gravely.)

Bell-shaped rock-cut tombs in laterite formations were reported from Malabar by Babington in 1819, but no detailed description is available so far. The site at Feroke was discovered by Prof. Jouveau-Dubreuil.

Description.—Hollow stupa-like, with an opening at the top and another down at the side, both closed by big stone-slabs. A flight of steps leading from the surface level towards the lower entrance. A raised platform in one of the tombs.

Finds.—Coarse earthenware, rounded four legged urns, pitchers, etc.; an oblong bath-tub like vessel with twelve legs, containing carnelian beads; large pyriform urns with lids, a large iron tripod, dagger, and several forked hooks of iron. Animal ash in one of the four-legged urns. Inscribed 'signs' on the pottery.

Local traditions about the tombs—Buddhistic.

Significance.—Not purely Aryan Agnidriyas as suggested by Prof. Jouveau-Dubreuil. The orientation, the urns with lids, the many legged tub, etc., are un-Aryan. Cremated remains, as in South Indian dolmens, may show foreign influence. These rock-cut tombs show a transition stage from the purely Megalithic culture—probably a blend of Aryan and non-Aryan funerary forms.

11. Pigmy flakes from Singanpore cave painting site.

P. Mitra.

The author on his way back from the Indian Science Congress at Nagpore last year visited the Singanpore cave (near Raigarh) with the rock paintings and collected several pigmy flakes of the late Capsian type at the bottom of the hill. This goes to confirm the conjectures that the paintings which are of the same style as the cave-art of North Spain were probably due to late Capsian settlements in that area, in India.

12. Polynesian and Vedic mythology.

P. MITRA.

The remarkable similarities in certain points between Indian and Polynesian mythologies such as evolutionary cosmogonies, the conception of the universe as an egg and the concept of a tree hanging upside down, etc., discussed as to their common origin or otherwise.

13. Adzes and shouldered celts from India.

R. C. RAY.

(Communicated by P. Mitra.)

A detailed study with cross sections of the adzes and shouldered celts and their distribution in India bringing out their remarkable Polynesian affinities and possible connections with the migrations of the Austric-speaking peoples.

14. The ringstone types in the Indian Museum.

SATKARI MITRA.

(Communicated by P. Mitra.)

The votive maceheads found in large numbers in the Indus valley are in type but massive ringstones. The Indian ringstones re-examined with weights and their distribution discussed.

15. Types of pounders in India.

P. MITRA *and* J. K. NAG.

The pounders had a remarkable development in the Polynesian area developing grips. The simpler conical types of pounders and beginnings of a shouldered type of pounder in India would bear comparisons with the pounder-prototypes in Polynesia.

16. Hammerstone types from India.

P. MITRA *and* NARESH CHANDRA SEN.

Hammerstones specially of the grooved type are rather rare in India. Their varieties and possible affinities with other types outside India.

17. The distribution and ethnic affinities of the Brachycephalic people in the various parts of India.

B. S. GUHA, Calcutta.

In this paper the author gives the preliminary results of his investigations and suggests the possible routes of migrations of the broad-headed people in different parts of India.

18. Craniometry of the people of Burma.

P. C. BASU, Calcutta.

(Communicated by Dr. B. S. Guha.)

In this paper the author gives the results of his investigations on the Burmese crania that have been obtained from an old site in Burma and are at present in the collection at the Anthropological Laboratory of the Indian Museum, Calcutta. The results obtained in the light of these studies have been compared with those of Turner, Tildesley and others so as to find out the basic elements that have entered into the constitution of the people of Burma.

19. A note on the Coefficient of Racial Likeness.

R. K. PAUL, Calcutta.

(Communicated by Dr. B. S. Guha.)

The difficulties in the estimation of the C.R.L. on the living. A critical review of the methods adopted by Prof. P. C. Mahalanobis and Prof. Karl Pearson.

20. On the technique of Extraction and Preservation of Pre-historic fragile bones.

H. K. BASU, Calcutta.

(Communicated by Dr. B. S. Guha.)

The extraction and preservation of the pre-historic bony remains is a very difficult task, specially in India, owing to the nature of the soil. The author discusses the various methods followed by scientists, and gives his reasons for the one he thinks to be most suitable for this country.

21. On the sanctity of the Dhvaja or Standard in India.

A. K. MITRA, Calcutta.

(Communicated by Dr. B. S. Guha.)

In this paper the author gives the result of his investigations on the morphology, emblems and significance of the Standard as represented in the ancient monuments, coins, seals and inscriptions, etc., and the ancient texts, chiefly the Epics.

22. On the introduction of the Four-horse chariot into India.

B. K. CHATTERJEE, Calcutta.

(Communicated by Dr. B. S. Guha.)

In this paper the author discusses the evidence from Indian and European Classical Texts as to what light they throw on the appearance of the four-horse chariot in India.

Section of Psychology.

President :—N. S. N. Sastry, Esq., M.A.

Presidential Address.

The Growth of Psychology in India.

Ladies and Gentlemen,

I wish to offer my heart-felt thanks for the great honour you have done me by asking me to preside over the deliberations of the Psychology section, though I must say that I never expected to get this honour so early in my life. I believe that it is my association with the Department of Psychology in the University of Mysore that has earned me this distinction rather than any special merit of my own work. Though I am fully aware of my own limitations, I venture to hope that with your goodwill and co-operation we may bring the session to a successful issue. My predecessors in this office have all been men of eminence and experience, to neither of which distinctions can I lay claim. With considerable trepidation of mind have I undertaken the task of preparing an address. Choosing a suitable subject has been a very difficult task. Circumstances over which I had no control confirmed the inevitableness of my accepting the Presidentship only a short time ago. Therefore you will pardon me for the very cursory and brief address that I will place before you. When I accepted the honour of presiding over this section, after much doubt and with a good deal of diffidence, I thought that I could make use of this opportunity to survey briefly the growth of psychology in our country.

Psychology is an old branch of knowledge. We can almost say that it is as old as humanity. Speculations in regard to the working of the human mind, with a view to explaining and predicting human behaviour, are at least as old as civilisation. In India the beginnings of the study of Psychology are to be found in the Vedas, which go back to the dim days of the past, marking already a certain stage of Aryan civilisation and culture. But little is known about Vedic psychology, though a careful study may bring to light a good deal about the endeavours of those people. The Upanishads that followed the Vedas, are a store-house of information in regard to the knowledge of the human mind possessed by those people. So I propose to trace briefly the growth of Psychology from the Upanishadic period.

The Upanishads are older than Panini and date back to about the 7th century B.C. It is really an extraordinary thing that at such an early period the thinkers in India should have so much Psychological reflection to their credit. The conclusions they arrived at and the methods they employed might not always call for admiration. But no one can ignore the efforts made by them to explain human behaviour. The evolution of experimental science was, of course, reserved for a later date. Yet here and there even in the Upanishads we find recourse to scientific methods of study.[1]

Speculations in regard to the nature of mind and its relation to the body, and in regard to the nature of will, attention, and intellect, are in great evidence in the major Upanishads. Mind, we are told in one place, depends upon the alimentation for its formation, 'the subtlest part of our food being transformed to mind.'[2] Attention is of the nature of concentration, and the process of inhaling and exhaling stops when one concentrates. This is the Pratardana sacrifice mentioned in Kaushitaki[3] Upanishad. An interesting instance of the analysis of an emotional state is also given in the Upanishads.[4] Fear is experienced by us only when the feeling of 'otherness gets lodgement in us,'—it is only from the idea of the existence of a second that fear proceeds.

The supremacy of will and intellect is discussed at great length in some Upanishads. Chandogya Upanishad first claims supremacy of will, saying 'that everything centres in will.' 'Choosing is a function of will.' The whole world is filled by will-force.[5] Yet the Upanishad tells us again that 'Intellect' is better than will, for, it is only the thinking man that can will. But mind certainly is the most supreme.[6] It is the source of all mental modifications. Each experience has the characteristics of volition and feeling. Volition is distinguished[7] from conation in that the latter alone involves the idea of action. One of the sources of sleep is said to be fatigue.[8] The Prasnopanishad says that sleep[9] is caused by the senses becoming collected into the mind. Soul, it is declared, moves during sleep from its seat in the heart into the arteries known as the Puritat.[10] Yet another

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[1] Brihadaranyaka Upanishad: Adhyaya 2, Brahmana 1, 15–17.
[2] Chandogya Upanishad: Prapathaka 6, Khanda 5.
[3] Kaushitaki Upanishad: Adhyaya 2, 5. Also, Chandogya Upanishad: Prapathaka 1, Khanda 3, 5.
[4] Taittiriya Upanishad: Brahmananda Valli, Anuvaka 7. Also, Brihadaranyaka Upanishad: Adhyaya I, Brahmana 4, 2.
[5] Chandogya Upanishad: Prapathaka 7, Khandas 1–15.
[6] Maitri Upanishad: Prapathaka 6, 30.
[7] Aitareya Upanishad: Adhyaya 3, Khanda 5.
[8] Brihadaranyaka Upanishad: Adhyaya 4, Brahmana 4, 18-19.
[9] Prasna Upanishad: Prasna 4, 2.
[10] Brihadaranyaka Upanishad: Adhyaya 2, Brahmana 1, 19.

explanation of sleep is that mind becomes merged [1] in 'Prana' or energy, and thus sleep is brought about. It is further held that in sleep alone does one come to know the real nature of some of the bodily functions, since sleep affords [2] a state when the body functions in the most natural manner.

In regard to the problem of dreams we note that the Upanishads maintain that an analysis of the dream experience is necessary if we are to have a clear notion of consciousness. It is sometimes held that it is not the real unconsciousness that is working during the dream state, but that the aspect of consciousness that is prominent during the dream state is midway between consciousness and unconsciousness. It is neither the one nor the other. This state is marked by the creative activity of the mind.[3] Though what one sees in dreams is merely the replica of waking experience, though dreams very often involve novel constructions.

There seems to be evidence of psychical research even in the Upanishads. Brihadaranyaka instances [4] the case of an exhortation of a spirit from the person of the daughter of Patanchala. Indeed, nothing is held to be impossible for thought. Thought-power is capable of making its [5] possessor realise everything. The knowledge that a sudden change takes place in the working of the heart in certain mental states seems to have influenced the Upanishadic seers in the theory of the spatial localisation of mind. The heart is said to be the seat of the mind. Whether by this term they meant the anatomical heart or the later Yogic 'Heart-Chakra' is not clear. In Yoga and Tantra consciousness is referred to[6] the brain. But Taittiriya Upanishad seems to believe that the soul (Manomaya) moves to the brain where it meets its lord (Manasaspati-Brahman). Though the physiology of the teaching is so poor, the attempt at psychological investigations is noteworthy. Soul is regarded as the master of all the senses.[7] Senses derive strength from the soul, 'even as poor relatives derive help from rich relatives.'[8] Soul is immanent in the body. Yet it is sometimes held that the soul is in the span's length from one's forehead to one's chin.[9] This discussion resolves itself into giving the attribute of non-restriction to the soul. It can be large or small, localised in a spot or all-pervading.[10]

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1 Chandogya Upanishad: Prapathaka 6, Khanda 8, 2.
2 Chandogya Upanishad: Prapathaka 6, Khanda 8, 1.
3 Brihadaranyaka Upanishad: Adhyaya 4, Brahmana 3, 9–18.
4 Brihadaranyaka Upanishad: Adhyaya 3, Brahmana 3, 1-2.
5 Chandogya Upanishad: Prapathaka 3, 4, 7.
6 The Positive Sciences of the ancient Hindus, Seal: 218-219.
7 Maitri Upanishad: Prapathaka 2, 3-4.
8 Maitri Upanishad: Prapathaka 2, 3-4.
9 Chandogya Upanishad: Prapathaka 5, Khanda 18, 1.
10 Maitri Upanishad: Prapathaka 6, 38.

Soul is characterised by the fact of consciousness. Consciousness is analysed into four states. The Mandukya Upanishad, in addition to the well-known three states, the waking, the dreaming, and the sleeping states, introduces the[1] fourth state, i.e. 'the Super-conscious' or the 'Self-conscious' state. The soul is said to be four-footed. The four states of consciousness represent the four feet, and they are respectively called the Vaisvanara, the Taijasa, the Prajna and the Atman.

In concluding this brief and cursory outline of Upanishadic psychology, I want to mention the theory of the 'Koshas' or the sheaths. A thorough and detailed study of the theory may yield a knowledge of the physiological counterpart of sensation, known to the Upanishadic seer. The terms, 'anna, prana, manas, vijnana, and ananda' rightly understood, might probably mean functional realities localised. In later days Samkara taught that these sheaths possessed only ideal existence. But whether the original expounders of the theory believed in Samkara's interpretation is doubtful.

The Upanishadic endeavours served as a very fitting background for the later growth of psychological knowledge. The freshness and vigour that is in great evidence in the Upanishads took hold upon the imagination of the people, and we mark a great advancement in philosophical speculation soon after the Upanishads. In fact, the seeds of some of the later systems are to be seen in the Upanishads.

The Geeta (Bhagavadgeeta), which may be considered next, is an important contribution to the growth of philosophy. Though it is a part of the great epic story of the Mahabharata, it is replete with suggestive contributions to our knowledge of human nature. It recognises the elemental connection of the senses. But the senses themselves do not claim reality. The perception of an object is conveyed by the mind (Manas) to the intellect (Buddhi) and then to the soul. Thus perception is not caused by mere contact. Mind is only a transmitting agent, but true knowledge is given only by reason, will and emotion. Intellect which is of the nature of knowing things in detail (i.e. Vijnana) or in oneness and group (i.e. Jnana) is different from intuition which alone gives the knowledge of the Real.

An important teaching of the Geeta is that the way the power of understanding and discrimination works (i.e. Buddhi) depends upon past habits.[2] But stimulation for action is the desire left by the impression of the sub-conscious, 'just as rain

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[1] Mandukya Upanishad: 2–7.
[2] Bhagavadgeeta: Chap. 15, 8-9.

stimulates the corn to grow.' The conscious mind acts,[1] produces impressions and judges, while the subconscious mind reacts and expresses itself.

The main teachings of the Geeta are to a great extent the same as the accepted teachings of the Upanishads. The stress laid upon the ways of realisation makes one believe in the great sociological end which the author of the Geeta had in view. Probably no other work in Indian philosophy has had so much attention bestowed upon it, or so many interpretations brought to bear upon it, as the Geeta.

The great attempt of the orthodox teachers in proclaiming the supremacy of the Vedas and the ultimate reality of Brahman, received resistance from the Lokayata school, who claim Brihaspati and his Sutras to be the beginnings of that system. It was a reaction from uncritical acceptance of teaching towards an acceptance based upon investigation, and it came as a great relief from ultra-idealistic views. The criterion of truth was perception, 'Prathyaksha' alone being 'Pramana.' Inference was not a criterion of truth, and ultra-physical activity of the mind was very strongly contested. Thought was merely a function of matter. When the four elements (earth, water, fire and air) combined in certain ratios, then a functional capacity was produced. Consciousness and intelligence are purely such functions. They are produced even 'as[2] the red colour is produced when slaked lime, areca-nut and beetle leaves are chewed.'

Thus the sway of the pendulum landed the philosophers in a purely materialistic psychological doctrine. The Lokayata, which held the supremacy of sense-perception, could have yielded better fruits, could have seen better days, aye, could have supplied the much wanted stimulus to the growth of physiological psychology, had it not been for the fact that it never found favour amongst the thinking public because of its palpably unsound and anti-social[3] ethics. Its teachings of utilitarianism and crude hedonism were extremely suicidal.

Jainism can be traced to about 500 B.C. It recognises the duality of body and mind, upholding a theory closely resembling parallelism. There are five sense organs (Indriyas). On the physical side they are represented by 'substance' (Dravya), while on the psychical side they are represented by 'ideas' (Bhava).[4] It is not too much to say that to Jainism goes the

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[1] Bhagavadgeeta: Chap. 13, 20.

[2] Sarvasiddhantasarasangraha—Samkara, Chap. 2–7.

[3] Cf. *Yāvajjīvam sukham jīvet* |
ṛṇam kṛtva ghṛtam pibet ||
Bhasmībhūtasya dehasya |
punarāgamanam kutaḥ ||

[4] Cf. Vaisesika.

I wish you a very pleasant stay in Bangalore and all success to the deliberations in which you are about to engage.'

After the reading of the Message Sir Mirza Ismail addressed the delegates as follows:—

'LADIES AND GENTLEMEN,

It is with some misgiving that I venture to confront this assembly of scientific thinkers and workers, but I take comfort in the thought that the good scientist is proverbially patient, even with the layman, with his inexpert, hurriedly prepared remarks. And I know you are practisers and admirers of brevity.

As you are aware, I have lately been one of a company breathing a very different atmosphere from that in which you, as scientific researchers, live. The politician, as I suppose I must describe myself, exists in an environment of his own to which he has to adjust himself in his own ways. I cannot help envying the lot of the man of science who seems to live in a region free from the rancour and suspicion, the excitement and disappointment, which often beset the path of the politician.

You, gentlemen, are engaged in a noble pursuit—the single-minded and unwavering pursuit of truth, as Nature half reveals and half conceals it. Sometimes this research is practical in aim. Sometimes it seeks truth only. Our age is apt to forget that the latter aim is the nobler; and that noblest of all are the strenuousness and discipline in seeking which make even failure a triumph of the spirit.

The mind of science is a modest mind; for it recognises that there are many things it does not know. It is a discriminating mind, for it tests and accepts or rejects as the test may tell. It is an open mind, knowing no passion or prejudice, unless it be the passion for truth as yet unknown, and the stern preference for truth discovered though it shatter theories or dreams.

The forces of Nature are the enduring wealth of mankind. But the command of the forces of Nature in the wrong hands can be turned from the highest purpose to the basest, most demoniacal uses, as was so painfully shown during the Great War; and who knows what may be in store for humanity in any such future conflict? "If, therefore, a scientific civilisation is to be a good civilisation, it is necessary that increase in knowledge should," in the words of Mr. Bertrand Russell, "be accompanied by increase in wisdom," meaning by wisdom a "right conception of the ends of life," "something which science in itself does not provide".

credit of supplying what is perhaps the most exhaustive analysis of sensation given in Indian writing. Touch has been analysed into eight kinds, hot and cold, rough and smooth, soft and hard, light and heavy. Taste has been analysed into five different kinds, namely, pungent, acid, bitter, sweet and astringent. Smell can either be good or bad. Colour has five distinctions, namely black, blue, yellow, white and pink. Sound has been analysed into the seven notes of Indian music, Sa, Ri, Ga, Ma, Pa, Dha and Ni. A thesis of Jainism is that consciousness, which exists in all things, could either be expressed or latent. Consciousness (Chetana), which is the essence of soul (Jiva), manifests itself in perception (Darsana) or intelligence (Jnana). Perception here is of the nature of simple apprehension, while intelligence is of the nature of conception.[1] Sense-perception is due to contact. It is followed by feeling which is due to past acts. Feeling is followed by conation and knowledge.

Knowledge is of five kinds : Mati (knowledge by means of senses and mind), Sruti (knowledge by acts of attention, understanding, association and aspects of the meaning of things), Avadhi (direct clairvoyant knowledge), Manahparyaya (Direct telepathic knowledge), and Kevala (perfect knowledge of the nature of intuition, comprehending all). The first three alone are liable to error. The last two can never be wrong.[2] Validity of knowledge is judged by its usefulness in showing good and evil. Error is committed when a thing is seen in relations in which it does not exist. Knowledge is of two forms, knowledge of the thing in itself (Pramana) and knowledge of the thing in its relations (Naya). The uniting of the subject (Jiva) and the object (Pudgala) is always due to the desire of the soul (Jiva). ' Pudgala ' is the physical matter which is made up of atoms (Anu), which form aggregates (Skandas). Every soul (Jiva) co-existing with material nature (Karma, which is paudgalika) becomes contaminated by it. This contamination of the soul by material nature produces human limitations.[3] This is the key to explain human behaviour.

A theory of evolution on a more satisfactory basis than is found in some parallel instances is accepted by the Jains. There is nothing fresh created nor is anything destroyed. What happens is only a fusion of elements to form fresh things. Different kinds of souls (Jiva) are recognised, the difference being based upon the number of sense-organs (Indriya) possessed. The lowest are those that possess only one sense-organ (Ekendriya) touch, and respond only to touch. Gradually other souls

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1 Dravyasangraha—43. (Sacred books of the Jains.)

2 Tattvartha Sutra—131, pp. 42. (Sacred books of the Jains.)

3 When Karma and Jiva come together, the eight kinds of Prakriti are given rise to. These kinds of Prakriti result in Karmana Sarira.

are evolved, which have two, three, four or five senses (i.e. touch, sight, smell, taste and hearing). The higher animals, man and gods, are characteristically rational, possessing the sixth sense, mind[1] (Manas). Consciousness, the possibility of which is in all souls always, comes into prominence only when the human stage is reached, more as a result of evolution rather than of any other cause.

Whether Jainism succeeded in its efforts at expounding a rational and faultless doctrine of philosophy, which was sufficient to explain human behaviour in its relation to the idea of the non-acceptance of a creator, is still debated. But there is no doubt that the extreme callousness ascribed to the Lokayatas received the timely check that was necessary, and a much greater stress than usual was laid on keen introspection. The study of philosophical problems received a more serious and dispassionate encouragement at the hands of the Jains than it had received at the hands of the later Charavakas.

Like the Jains, Buddhists also deny the existence of any intelligent first cause. Neither recognise the authority of the Vedas. There is no recognition of a permanent self. Nagasena[2] maintains that the self of a man is a unified complex. Soul is the name given to the sum of states that constitutes our mental existence.[3] Mind itself is a composite of mental forces, and it has an organised system of unity in it. Mind and body make up the individual, Nama and Rupa respectively. Whatever the individual is, is due to the interaction of mind and body. Emotion or heart (Chitta), consciousness (Vijnana) and mind (Manas) are all mental (Nama) in character. The product of the external world is characteristically physical (Rupa). Thus, man is a psycho-physical organism, the relatively stable part of which is the body (Rupakaya), while the unstable is the mind. Perception, conception, feeling and conation are functions of the mind. Perception is caused by contact (Phassa). Then arise feeling (Vedana), and volition (Samskara). Perception (Samjnana) is here also a cognition of general relations. This, when it includes feeling, is complete awareness, i.e. cognition in its fullest[4] sense. Consciousness is of the nature of a stream, and the core of consciousness is a series of cognitions (Citta

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1 Panchastikayasamayasara—118–126, 128. (Sacred books of the Jains).

2 Milinda Prasna—ii, 1, 1. (Sacred books of the East.)

3 Buddhaghosa's Visiddhimagga, in Warren's Buddhism in Translations.

4 Buddhaghosa's Atthasalini—145-146, in The Expositor—Mrs. Rhys-Davids and Maung Tin.

Santana). But, though consciousness is of the nature of successive stages, we always take it to be a unitary process.[1]

All the five senses (sight, touch, sound, smell and taste) do not come into touch with objects. Those that come into touch (asamapattarupa) are smell, touch and taste. The other two (sight and sound) do not (Sampattarupa). The former may all be regarded as merely modifications of touch. The external phenomena are caused by the impinging of the senses on the objects and the consequent modification of the individual and the objects. The doctrine of Pratityasamutpada holds that the object thus perceived can be either sensed, imagined, or remembered. And such perception is characteristically hedonistic. In fact, every act has three phases; volitional preparation, the act itself and the feeling that follows the act. The human-being is a unit of the world and his entire nature can be measured by a consideration of the five aggregates (skandas) that constitute his nature. But when the individual gets a true insight into things, the aggregates do not help us to understand him. Now he possesses the highly complex mode of insight (Prajna), the natural culmination of which is intelligence (Buddhi).

Desire (Chando) and effort (Viriyam) are both characteristic of will (Samskara). Will is supreme. Every activity in a sense is a modification of will; and thus every activity is purposive. This is the distinctive feature of human activities. But sometimes we cannot get to know the real nature of an activity since inhibition may cloud the nature of activity.[2]

Nagasena holds that an idea having occurred tends to occur again, since it is easier for it to occur again.[3] There is a consistent vein of associationism in the Buddhist exposition of psychological doctrine. Every mental act is momentary, but each act has a lasting effect upon the mind.[4] Every act is related to the next in at least four different ways; proximity (anantara), contiguity (samanantara), absence (n'attihi) and abeyance (avigata). That is why memory is possible. In fact memory is the causative influence contained in the present. Yet a number of things are not remembered. Conscious state is never steady. It is sometimes active and sometimes inactive (viddicitta and viddimula). The inactive consciousness is unconsciousness. Between these two phases of consciousness is a threshold (manodhvara).

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1 Buddhaghosa's Atthasalini—143-144; also Buddhism—Mrs. Rhys-Davids.

2 Inhibition of a bad impulse is achieved in five ways: attending to some other good idea, realisation of the undesirable consequences, turning attention from the present impulse, analysing the impulse and thus working it out and coercing the mind to act otherwise.

3 Buddhism in Translations—Warren, ii, 3, 7.

4 Aniruddha's compendium of Philosophy—Abhidammattha Sangraha.

Thus was started one of the most important schools of Indian thought, whose psychology was characterised by the critical analytical power displayed by its early teachers. The nature of the doctrines suggests that an extraordinary faith was placed upon human experience as such, which came to be relied upon as a sufficient starting point for psychological speculation. But the original teachings of Buddha contained the seeds of different doctrines. So the later teachers developed, on the same supposed basis of the Master's teachings, four different schools of thought. The Mahayana schools are the idealists represented by the Yogacaras and the Madhyamikas. The Hinayana schools are the realists represented by the Vaibhasikas and the Sautrantikas.

The Yogacaras (Vijnanavadins) place faith upon mental creation. Consciousness is a concrete reality. It works either as perception (khyati) or interpretation (vastuprativikalpa). And it is consciousness which develops the world of experience. Things are nothing more than a bundle of sensations. But the world of conscious states is certainly much more than our personal consciousness, which is only a fraction of the totality of consciousness (alayavijnava). There is a great deal which is unconscious. Our dreams, for instance, are due to the functioning of ideas which are generated in the region of the unconscious. Ideas leave impressions, and these impressions act as generators of ideas, and do not depend upon external stimuli.

The Madhyamika school[1] owes much to one of India's most profound thinkers, Nagarjuna, who is supposed to be a South Indian Brahmin convert. According to Nagarjuna the world is merely the product of a number of relations—it is a complexity of relations. The whole world of experience is nothing more than appearance. Everything is momentary. Stimuli are received from the external world and elaborated to a complexity with a number of attributable relations and qualities. The objects exist because of our senses. Sensations generate ideas and ideas generate sensations, both being inter-related. Perception is similar. Hallucination is also of the same nature as perception, so far as the play of mind is concerned, but it is a different existence.

To the schools of Hinayana belong the Vaibhasikas. To them experience, which is of the nature of knowledge produced by contact, is evidence enough of the truth. Experience consists of two parts, perception (grahana) and conception (adhyavasaya). Perception gives us only an indefinite presentation, while in conception we have a definite and ideal presentation. Our becoming aware of the external world is no creation in any sense; it is merely recognition or discovery. The five organs and their proper functions give us perception,

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[1] Also called Sunyavada.

which rouses the mind (citta) and excites consciousness (Vijnana).[1] Memory is merely a characteristic of the mind, and hence it is a Cittadharma.

The Vaibhasikas lay stress on the objective as well as on the mental world. Knowledge is a direct awareness of objects, and it is sufficient to give us truth. The Sautrantikas, who form the second group in the Hinayana school, also believe in the extra-mental existence of the objective world. Only they hold that we have no direct knowledge of it. We only infer of its existence because we have perception. But this outside world is only momentary. The illusion of the permanency of objects is caused in our consciousness by the fact that the perceptions are so rapid.[2] Cognition (Jnana) is the manifestation of a form caused by the senses.[3] Self-consciousness, which is not recognised by the Vaibhasikas or the Madhyamikas, is advocated by the Sautrantikas.

There is no doubt that Buddhism played an important part in the growth of Indian thought. Samkara seems to be clearly influenced by the Madhyamikas. The bold denial of God as such by the Buddhists acted as an extraordinary impetus for the exercise of that keen analytical power which was displayed in later expositions of the theistic doctrines, and which sometimes resulted in a better recognition of psychological truths. The theistic (or orthodox) schools of Indian thought are the Samkhya, Yoga, Nyaya (and Vaisesika), Mimamsa and the Vedanta.

The Samkhya school is supposed to have been originated by Kapila, who lived a century before Buddha. Yet it seems to have been anticipated in earlier teachings. Isvara-Krishna's Samkhya-Karika is the most popular work of the school.

Samkhya views the Universe as an organised whole, ever changing, only one phase of it being seen by the human mind at a time. A fact of knowledge is that the subject as well as the object must be affected. But the human mind possesses complete independence and freedom. Evolution (avirbhava) is more psychological than physical, and is an aspect of change. The other aspect of change is involution (tirobhava). Change could also be one of quality (dharmaparinama) or of form (lakshana). The Universe has for its basis indeterminate nature (avyaktaprakriti) which has transformed itself to the present state. Nature is the basis of creation. Its development is conditioned by its possessing the three aspects or powers (gunas),

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[1] Vasubandhu—Abhidammakosa, 2.

[2] Sarvasiddhantasarasangraha—Samkara, iii, 3, 16.
'Just as an arrow passes through the petals of a flower.'

[3] Sarvadarsanasangraha, p. 36, translated by Cowell and Gough.

the potential consciousness (Sattwa), activity (Rajas), and inactivity (Tamas).[1]

From the unconscious nature there evolves for each soul a universe. The first product of matter is intelligence (Buddhi or Mahat[2]). It is the subtle mental stuff which is capable of knowing pleasure and pain. Memory trends are stored in it. Its function is knowing and deciding, and thus it gives rise to a notion of self (Ahamkara). First, the soul experiences consciousness. Then the self becomes aware of the not-self and thus of its own individuality. It has the feeling that 'I am seeing.' Then the self becomes aware of the object, which helps it to realise self-sense. Self-sense (Ahamkara) is midway between mind and intellect. Our perception and decision depend upon intellect. But it is due to the working of the self-sense that we come to realise that the impressions received are our own. In a sense it individualises them. All our actions depend upon the dominence of a 'Guna' on 'Ahamkara.' Mind communicates the outside sensations to the self. Thus a concept is arrived at. The action of the principle of 'Ahamkara' is to refer to the self the suggestion of action sent up by the mind. 'Ahamkara' is supposed to come prior to the objective world. Thus a possibility of the rise of an 'Ego' sense even without the sense of a 'Non-Ego' is granted by the Samkhya.

Ahamkara in its *sattwa* aspect gives rise to mind (Manas). Then are derived the five organs of perception (Jnanendriyas[3]) and the five organs of action (Karmendriyas). Ahamkara in its *tamasic* aspect gives rise to the five elements (Bhutadi[4]). But Ahamkara in its *rajasic* aspect plays part in both the other states.

The function of mind (Manas) is to synthesise the senses[5] into a percept.[6] Mind also is an organ like the other ten. Besides arranging the senses, its function is to suggest alternative courses of action and carry out the decision of will through the five organs of action. There is no difference between function and organ in the intellect, self-sense or the mind, which form the 'Anthahkaranas.'

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[1] Satkaryavada holds that aspects are more predominant than gunas.

[2] Cf. Katha Upanishad: 3–11.

[3] Cf. Yoga. There are two parallel lines of evolution starting from Mahat. On the one side it develops into Ahamkara, Manas and the five Jnana, the five Karma indriyas. On the other side it develops into the five tanmatras and then five gross elements.

[4] Yoga does not recognise this.

[5] Through the sense organ Buddhi comes into contact with an object. Then it assumes the form of that object. The power of consciousness (Cetanasakti), because of its union with Buddhi, takes the form of the modification of Buddhi. It is this that is apprehended.

[6] Tattvakaumudi, p. 36.

In perception, the senses, intellect, mind and the self-sense come into operation. Intellect, mind and self-sense act only in memory. Perception is not sensation. The former is active while the latter is passive. Perception can be indeterminate or determinate. First, there will be indeterminateness. The next instant mind begins to operate. By analysis (Vikalpa) and synthesis (Samkalpa) the definite nature of the object is perceived.[1] The impression received by the sense-organ is given to the Ego by the mind and then to the intellect (Buddhi). Mind is both passive and active, i.e. it can receive as well as react. Valid knowledge (i.e. perception, inference and scriptural authority) is cognitive consciousness. Knowledge which is perceived by sense activity is perception. When, for instance, a jar is within the field of cognition, intellect (Buddhi) assumes the form of the jar.

Recognition (Pratyabhijna) is possible because the enduring intellect becomes modified in perception and it retains trends of such modifications. The same thing affects different people in different ways because different intellects contain different impressions. Every object cognised as a form is so because its modification depends upon purpose.

Another point of interest to the Evolutionist is, that need is the necessary impetus for the creation of a function. Need precedes function. Necessity is the urge for invention. Any desire on our part necessitates the creation of a function. We want to taste fine food, and so functional capacity to taste fine food arises. In this way the evolution of a structure which is capable of sensing becomes necessary. The senses are not the organs of the mind, they merely observe. The fine elements (Tanmatras) combine to form atoms.[2] It is only then that they act as sense stimuli. All sensations are modifications of sound. It is the different arrangements of atoms that gives rise to different stimuli which so act as to give the idea of different qualities.

Intellect (Buddhi), Mind (Manas) and self-sense (Ahamkara) as evolutes do not suggest any historical order or generation. They are intended merely to suggest the psychological functioning of the individual. According to Tarkakaumudi, every individual first gets the stimuli from the external world with the help of his sense organs. Then his mind arranges and organises these impressions. Then this organised whole of impressions with its accompanying impulse to act is conveyed to his Ego (Ahamkara). Then his intellect comes into operation and he decides the course of action.

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[1] Cf. Vacaspati Misra holds that any perception presupposes activity of the mind. Vijnanabhikshu believes that Buddhi could directly come in contact with the object through the senses.

[2] Cf. Chandogya Upanishad: IV, 4.
Taittiriya Upanishad: ii, 1.

But the knower of all these is the self-consciousness (Purusha) in the individual. The concept of the Purusha is akin to the concept of the Atman in the Upanishads. All the modifications of matter detailed above are for the sake of the spirit or the principle of self-consciousness in the individual. The true nature of this principle is difficult to understand, since its working is clouded by the workings of the attributes of matter (i.e. Dharma, Adharma, Jnana, Ajnana, Vairagya, Avairagya, Aiswarya, Awaiswarya. But here 'Jnana' is capable of showing the true nature of 'Purusha'). 'Purusha' is a higher entity than intellect or mind, which are merely means of giving knowledge. Consciousness is like a number of streams, not one. The principle of self-consciousness brings about the unity of such separate streams. 'Purusha' is of the nature of consciousness (Cidrupa). It is an abiding principle always present, 'even as an ever present witness'. It is present in the waking, sleeping and dreaming states also. It is not a form of energy. It is the principle illuminating the whole working of the individual.

So, in an individual's behaviour we have the operation of intellect, individuality, mind and the ten organs. Self-consciousness does not directly enter into it. Thus behaviour is thirteen-fold.

The self in conjunction with the senses (Purusha and Ahamkara) and limited by the body is 'Jiva.' Jiva is made up by the gross body and the subtle body (Lingasarira). The 'Linga' by itself is non-conscious. When matter (Prakriti) and spirit (Purusha) come together, the 'Linga' becomes conscious. Matter is blind, but proximity to spirit enlivens it.

The character of the Samkhya doctrine seems to be more scientific than religious. The importance attached to its doctrine of evolution, and the discussions about the nature of evolutes, seem to suggest the supreme importance laid upon the individual. The basis of its doctrine is not so much the pure consciousness as the individual, who is the unit of the human world. This stress laid upon the individual brings the doctrine nearer to the modern view that the individual is an organism whose self is not merely that organism, nor is his life merely the mechanism that keeps up the life process. The Samkhya school started with very important questions and very inspiring ideals. Had it been its good fortune to pursue its deliberations still further, it would probably have succeeded in giving to the ancient world one of the most complete systems of psychological thought. Its doctrine is perhaps unique in this respect, that it set out with the ideal of arriving at a comprehensive view of the Universe, keeping in view and taking into account all the facts of reality.

The metaphysical setting of the Samkhya served as a fitting background for the Yoga doctrine. Its chief exponent and founder, Patanjali, accepted the Samkhya metaphysics with his own modifications. But the psychology of the Yoga was at variance with that of the Samkhya, probably because of the purpose in view. Let it not be understood that by this is implied that the seers started with a presupposed scheme of things. There is ample evidence to show that the search was started purely in a scientific spirit.

Though Patanjali is practically the founder of the system, the doctrine profited much by the later writers like Vyasa, Vacaspati and Vijnanabhikshu. The system seems to have influenced the whole of later Indian thought in a peculiar way. Though the heretical Yoga is condemned and the orthodox praised, the former still claims some votaries.

Yoga aims finally at the suppression of mental activities. It is supposed to help us to reach a higher level of consciousness through the transformation of psychic organism, which enables us to get beyond the limits of ordinary human experience. It is a system of developing great inhibitive powers. It is a course of exercises which helps us to restrain the senses and the mind.

The relation between the body and the mind is recognised, and probably no other system lays so much stress upon the interdependence as the Hathayoga. The senses are the channels which carry the sensations to the Citta. The external objects thus affect the Citta. It is then that perception, which is a means of knowledge, is caused. It is by means of the Citta that the self becomes aware of the objective world.[1] Self (Purusha) is the seat of knowledge. Intelligence (Caitanya) is reflected in Citta, and it assumes the form which is conditioned by Citta. Thus is knowledge obtained. Citta is affected both by the subject as well as by the object. But only one impression at a time can be produced in the Citta and it leaves a residual which is the cause of interest, desire, etc. Consciousness is a quality of the Citta. Any modification of the impression brought about by the mind is directly related to the object. When such a process occurs, it leaves an impression. This impression is often of the nature of a tendency (Samskara). A number of such allied tendencies form in the aggregate a disposition. The act of recognition is called memory.

Citta[2] is the highest form of matter. It includes in itself intellect, self-consciousness and mind. It is essentially non-conscious. It is capable of contracting (as in the case of animals) or expanding (as in the case of human beings). When it manifests itself a state of consciousness, it is called Kariya Citta.

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[1] Yoga Sutra: i, 2, ii: 6, 17, 20.
[2] Cf. Mahat of Samkhya.

Mind can be directed at only one point of attention. In that state it is called one-pointed (Ekagra). This state is seen only when the mind is *sattwic* in its nature. When mind is alternating between a number of objects, now attending to one, now to another never fixed on any single idea, it is characterised as restless and is supposed to be *rajasic*. It can also be *tamasic* when it is characterised as blind.

A very important contribution, which is made more clear in Yoga than in other allied systems, is the idea of a state of mind which can think in terms of pure notions only. A balanced state of mind can be attained when the meaning of words, essences of concepts, deliberations, help us to hold an object in mind. But there is another kind of balanced state of mind when it is not helped by relations, words or memory (i.e. lasting impressions which cause recognition), but when only the object, just as it is in itself, is comprehended by the mind. It is here that we have the recognition of a state that is akin to notional consciousness. Thus the modifications of the mind are not always present nor are they necessary. This higher state of notional thinking must be cultivated by the Yogi, because the lower state, which is characterised by the modifying activity of the mind, is a state when mind is affected by the latent tendencies caused by mental modifications. These tendencies, which are always subsisting in the unconscious, sprout up in the conscious when occasion occurs. So the Yogi must not only allow room for these modifications, but must also destroy the dispositions in him that are brought about by aggregate tendencies. Thus it is that the Yogi is asked to cultivate the higher state of mental functioning.

The ways and means of this attainment are exhaustively treated in the Yoga. The withdrawal of the senses from their capacity to function (Pratyahara) is a prescribed method. This process of introversion is believed to be a better way of attainment than the annihilation of impulse. When the Yogi tries to attain the so-called attainments (Siddhis), then his method is somewhat akin to a process of self-hypnotisation. To facilitate this process, certain bodily and mental exercises are prescribed. In fact the so-called supernatural phenomena—television, clairvoyance, thought-reading, etc.—are treated just like natural ones capable of simple natural explanations. But the Yogi must regard the exercising of these powers as obstacles to concentration (Samadhi).

The Yoga system, with its emphasis on the education of the soul and the controlling of the capacities of the self, began slowly to degenerate to unworthy practices such as magic, mesmerism and so on. The Yogis became identified with charlatons, Tantricas and others who aimed solely at the attainment of the Siddhis. Thus it slowly became mystic and heterodox, and began to be looked down upon. The original purity

But it cannot be denied that, on the whole, the progress of modern science has been of the highest possible benefit to mankind in every field of human endeavour. Knowledge without wisdom may be dangerous, but I believe that knowledge generally produces wisdom. Thus will humanity progress through time asserting its supremacy more and more over the forces of Nature and utilising them for its own benefit, both moral and material.

This Congress stands for all that is most worthy in scientific research. During its comparatively short life of eighteen years, it has come to take a place of national importance. The value of your annual sessions in instigating, encouraging and co-ordinating research can hardly be over-estimated. To you, as a body, must be due much of the credit for the position now taken by Indian researchers in the very forefront of the modern world's scientific advance. It is significant that the present enthusiasm for original investigation in India, which has so rapidly produced such striking results, has grown during the period dating from the inception of this Congress.

In concluding, gentlemen, let me assure you that Bangalore is honoured by your meeting here for the third time. We extend to you a most hearty welcome: and we hope that your visit may be a most enjoyable and interesting one, and that the fullest possible measure of success may attend this Session of the Indian Science Congress.

I will now declare the Session open, inviting Professor Kashyap to assume his office of President.'

After the opening of the Congress, Rai Bahadur Prof. S. R. Kashyap delivered his Presidential Address.

At the conclusion of the address Prof. S. P. Agharkar moved a vote of thanks to Sir Mirza Ismail for having consented to open the Congress, which was carried by acclamation.

of purpose was lost sight of. Even today the Yogic practices are fanatically reserved and restricted. With proper study and practice it is bound to yield excellent fruits, especially in the branch of abnormal psychology. Modern psychology would be greatly enriched by proper and scientific researches in this field.

The Nyaya and Vaisesika schools represent what may be called the analytical type of Indian thought. They give pre-eminently a critical treatment of metaphysical problems, relying on common sense and science. The 'scientific' treatment of problems seems to be a distinctive feature of these schools. As compared with the Samkhya, they represent an increased naturalism.

All knowledge is supposed to have been originated, because of the fact that it has a background of reality. It is the mental or ideal reconstruction of this fact of reality which we call knowledge. Knowledge is of two kinds, cognitive experience (Anubhava) and knowledge due to former states of consciousness (Smṛti). True knowledge has always got a pragmatistic value. According to the Nyaya Sutras of Gotama, the forms[1] of knowledge depend upon the four 'Pramanas', intuition (including sense-perception), inference (Anumana), comparison (Upamana), and verbal testimony (Sabda). Sense-perception is caused by the contact of the sense organ and the object (Prapyakari), but it is conditioned by the mind (Manas). And it is not the self either, and because intellection (Buddhi) is merely a quality of the self, it is not intellection either.

Our consciousness is comparable to a stream.[2] Perception is never simultaneous. We can have sensations only in succession.[3] Perception follows upon the modifications of the soul, produced by the contact of the senses and the objects. These perceptions stamp impressions upon the mind even as a seal stamps impressions upon wax; and the mind retains these impressions.

The characteristic feature of knowledge is that it is inexpressible (Avyapadesyam), simple apprehension (indeterminate perception) characterised by the absence of relations. Determinate perception (Savikalpika) is a later stage characterised as perceptual judgment. According to Annambhatta, we can only be sure of this determinate perception, since indeterminate perception, though a fact, can only be inferred. This

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[1] The Nyaya Sutra—Gotama, 1, 1, 3. Translation by Vidyabhushana.

[2] The Nyaya Bhasya—iii, 2,—Jha.

[3] The Nyaya Sutra—Gotama,—1, 1, 16. Translation by Vidyabhushana.

fact of mere awareness (Vastuswarupamatra), is recognised also by some of the other Naiyayikas.

Perception is itself of four kinds: sense-perception, mental perception (Manovijnana, i.e. after-images,[1] etc.), self-consciousness (feeling of pleasure, pain, etc.) and intuition. Sense-impressions are the sources of knowledge. Knowledge is merely a function. Senses supply material to the mind, and 'intellection' makes the work of mind intelligent, i.e. it helps the formation of concepts which save perception from remaining blind. Recognition is a kind of qualified perception. In recognition what is perceived is a present object conditioned by the qualifications of the past. But memory is not recognition (Pratyabhijna), because memory is caused solely by the impressions left on the mind (Samskaramatrajanya). Recognition is caused by the identification of the present object with the past one.[2] Memory knowledge is based upon residual traces (Samskarajanya) and is due to the contact of the soul with the mind and the residual traces.[3]

Error may be due to any of the following: object, medium (e.g. light, etc.), sense-organ, mind or the self. But all error in a sense is subjective, because all impressions are merely subjective elaborations. Error is seeing a thing as other than what it is (Anyatakhyati) and has an objective basis.[4] It is due to wrong synthesis of the facts given at the 'nirvikalpa' level. 'Nirvikalpa' perception can never be wrong.

Illusion is due to a defect in the sense-organ (Dosa), partial perception (Samptayoga), and mental prejudice (Samskara, i.e. habit producing irrelevant recollections). Illusions are to be distinguished from hallucinations in that the former have an objective basis, while the latter have no objective basis (Adhistana).

But to the psychologist the importance of Nyaya teachings is the analysis of action. Activities are never purposeless. They always have (1) motive (Prayojana), (2) attainment of pleasure (Sukhaprapti) and (3) removal or avoidance of sorrow (Dukhaparihara). Activities may be characterised by the presence of will or they may be purely instinctive and automatic[5] (Jivanayonipurvaka). This is due to the survival of the memory of a previous (life's) experience. Here, perhaps, alone in all Indian thought is a dim recognition of the fact of instinct.

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[1] Eye must stop working in manovijnana.

[2] The Nyaya Sutra—Gotama, 3, 2, 33–36. Translation by Vidyabhusana.

[3] Nyaya varttika—iii, 1,—Jha.

[4] Nyaya varttika—1, 1, 4.—Jha.

[5] Among examples of this recollection, is the infant's 'readiness to suck.'

Activities may also be due to the perverse action of the three characteristics of the soul; attachment (Raga), aversion (Dvesa) and stupidity (Moha). Aversion includes anger, envy, malignity, hatred, implacability, while attachment includes lust, avidity, avarice and covetousness. Stupidity breeds both attachment and aversion. Dreams originate both from external and internal stimuli. They are merely revivals of subconscious impressions.[1]

The Vaisesika school is very closely allied to the Nyaya school. It is held by some that this doctrine is older than the Nyaya doctrine. Kanada (the author of Vaisesika Sutra) seems to be older than Gotama. The Vaisesika doctrine takes a more scientific and analytical view of experience than the Nyaya. On some of the main principles they are both agreed; but while the Vaisesika is extremely scientific, the Nyaya outlook is slightly empirical. The Vaisesika upholds the atomistic conception of the Universe, although atoms themselves can never be perceived. What is perceived is the substance, quality, action, etc. There are four kinds of valid knowledge (Validity depending upon its capacity to enable us to apprehend substances which are perceptible); perception, inference, remembrance and intuition (prathyaksa, laingika, smṛti and arsajnana, respectively). The senses are the source of all knowledge. Invalid knowledge consists of doubt (samsaya), misconception (viprayaya), indefinite cognition (anadyavasaya) and dreams (svapna).

The sensations are analysed more or less as is done by the Jains. Colour is divided into seven varieties; white, blue, yellow, red, green, brown and variegated. Taste can be sweet, sour, pungent (katu), astringent (kasaya) and bitter (tikta). Odour is either fragrant or bad, while touch can be either hot, cold, or neither hot nor cold. Actions are due either to the organic impulse to live (Jivanpurvaka), or to desire and aversion (Iccadvesapurvaka). Affection for objects is caused by pleasure. Pain causes aversion to objects. Desire and aversion are volitional reactions to pleasurable and painful objects.[2] There is no higher activity than that due either to attachment, aversion or organic impulses (Jivanayonipurvaka).

Consciousness is the activity of the soul; but this activity is seen only when the soul is confronted by the non-conscious world. The soul is distinct from the body or the senses. This activity of the soul, characterised as consciousness, is due to

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[1] Kanada attributes dreams to the union of the self and the mind helped by subconscious impressions. Sridhara believes that dreams are centrally excited. Prabhakara says that dreams reproduce past experiences which however appear as immediate ones.

[2] Prasastapada's Padarthadharmasamgraha, 259,—Jha.

the interaction between something outside us and our mind. The mind is merely a blank wall upon which ideas and experiences find a place. The world outside conveys ideas to this mind in regard to its nature. The cognition of the external world is due to the functioning of senses and mind. This cognition becomes possible by reason of the fact that the soul, the mind, the senses and the qualities of the objects are all interrelated. But all these are atomic—even mind. Knowledge which is non-continuous is not a permanent attribute of the soul.

The main difference between these systems of Nyaya-Vaisesika and the other systems of Indian thought is perhaps the nature of the method of study. These systems give a scientific treatment of knowledge, in which body and mind are regarded as different. Mind is, in a sense, eternal ; and keeps in itself the residual impressions and effects of actions. It is continuous, though at any moment it presents only a phase of its activity. These systems recognise the survival of memory knowledge even in different lives.[1] Mental phenomena seem to have attracted the teachers more than the purely metaphysical problems of the self.

The Mimamsa is divided into two parts—the former (Purva) and the latter (Uttara). The former deals mostly with rituals and religious practices, while the latter concerns itelf mostly with philosophical speculations. The latter is supposed, also, to give a true knowledge of things. Jaimini, who wrote the Mimamsa Sutras, is the first famous exponent of the system. Though the Sutras are more concerned in directing the performance of rituals, the first chapter is important to the psychologist. Prabhakara and Kumarila are the two notable Mimamsakas who have to be considered next. Both of them are champions of the orthodox Vedantic school, and their earnest endeavour seems to be to place Vedanta on a sound basis.

Jaimini mentions only three Pramanas, namely, perception, inference and verbal testimony. Prabhakara adds two more (analogical and implication), while Kumarila adds analogy and non-comprehension. In their opinion mind (Manas) gives rise to pain, pleasure, etc., but qualities like colour, smell, etc., are given by the medium of senses. Perception is thought to be a quality of the self, and due to the sixth sense (Manas).

Perception is apprehension (Saksatpratitih) due to the contact of the senses and the object. Kumarila holds that

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[1] The child instinctively begins to suck and the remembrance of taste makes our mouth water!

perception is always related to the object that exists. Prabhakara believes that the perceived object may be a substance or a class. Perception is indeterminate in the beginning, but later becomes determinate. According to Kumarila, indeterminate perception is the result merely of the contact of the senses and the objects. It is mere awareness[1] and devoid of all relationships. This perception, of the nature of mere awareness (Sammugdha Vastu Grahana) or observation (Alocana), is comparable 'with that of the new-born baby.' This perception is due to the object itself, and it is only when we use relationships to help us to get a clear perception of the object, that perception becomes determinate.

Prabhakara believes that in indeterminate perception (Avikalpa) there is a knowledge of the genus and species of the generality and individuality of the object. But in the very next moment other objects in our knowledge, owing to their interaction upon the new object,[2] make the perception determinate (Savikalpa).

Mind can work only through the senses. It is of the nature of an atom, and works very rapidly. The self has the nine qualities—intellect, pleasure, pain, desire, hatred, effort and memory traces. It is the relationship of mind and self that arouses these qualities. But, after mind has cognised pleasure, pain, etc., it is not possible for it to introspect those events. It is only the non-cognitive activities that could be mentally perceived. Pleasure, pain, etc., are purely mental in character.

Dream-cognition is due to the rousing of certain impressions retained in the mind. The condition of the subject must be such that it makes it possible for these impressions to work. It is only the impressions that have an emotional importance that can work in dreams. Mind may not be in contact with the senses during a dream, but self is in contact with mind. And according to Prabhakara, when this contact between mind and self ceases in sleep, then deep dreamless sleep is induced.[3]

According to Prabhakara all consciousness is self-consciousness too. Apprehension of the object is self-evident, and cognition, though self-cognised, is inferred. Kumarila believes that cognition is both directly perceived and also inferred, and it is self-evident. So, according to Prabhakara, cognition becomes an object too. Direct apprehension (Anubhava) is valid, but remembrance (Smṛti) is not valid, 'because the latter must have previous apprehension.'[4]

Valid cognition, apprehending the object, prompts us to action. Prabhakara analyses action as (1) sense of duty, (2) desire to do, (3) volition (Pravṛtti), (4) motor reaction (Cesta)

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1 Parthasarathi Misra in Sastradipika, 110. 2 Gestalt ?
3 Prabhakara school, ii—Jha.
4 Prabhakara's Mimamsa, 39,—Jha.

and (5) the act itself. All knowledge is self-valid, for even when a shell is mistaken for silver, it is a valid cognition. Error may be due to organic causes or defects in the senses, or to subjective causes. In the case of subjective error we mix up present cognitions with past ones. That is to say, when an object is cognised, before cognition can be full, the several attributes of the object must be cognised. But if wrong attributes are derived from the presentation, then error is caused. In this way the education of wrong relations causes error. Here, error is of the nature of commission.

Error may also be caused by omission. When one says 'This is silver,' on seeing a piece of shell, the perceived object 'This' and the remembered object 'silver' are both true. But the non-discrimination (Akhyati) of these two factors as distinct and separate leads to error. Doubtful cognition is also valid. When a doubt is expressed as to whether an object is a man or a post, the cognition is valid. But little or no comprehension is erroneous cognition.

Self itself can be the subject of perception. According to Prabhakara, the presence of this self originates the capacity to recognise and remember. It is so because the phenomenon of recognition has two elements in it; recollection (Smṛti) and the previous perception of the object (Purvanubhava). Now, the fact that one can remember a past cognition means that there is a permanent self where past perceptions and recollections are stored. Parthasarathi Misra holds the opinion that the self can be both the subject as well as the object of perception. The other systems of thought said that memory trends were left in the mind. But Mimamsa, with the avowed object of appearing very orthodox, merely substituted self for mind.

In Mimamsa, after considering Jaimini and the two great commentators Kumarila and Prabhakara, we must refer to Badarayana. His Vedanta Sutra is important as the rallying point of the later Acharyas. Of its four chapters, the third one alone gives us little psychological information.

The variety and richness of the Mimamsa teachings were responsible for claiming the famous three Acharyas to their own school. Perhaps the most profound and the best known of them was Samkara, whose Advaita system is probably the best example of a pure philosophical system of thought. He lived about the middle of the sixth century,[1] and his teacher was Govinda, whose teacher Goudapada was almost the first exponent of Advaita. Goudapada's teachings are characterised by a bold analysis of experience and the rejection of shallow

[1] Cf. Some think he lived as late as 800 A.D.

traditional explanations. He says that dreams are as real as waking life, and that they in their universe are as organised as the experiences of the waking life. Bhartrihari, the famous grammarian and logician, lived earlier than Samkara. Samkara's views seem to have been influenced by Bhartrihari's views. Bhartrihari's fundamental idea is that the world of experience is purely ideal and imagined (Kalpanika).

Samkara seems also to have been influenced by Buddhist teachings,[1] though he always placed great faith in the Upanishads. He viewed the Nyaya Vaisesika doctrines as loose and common-place, while his own method was remorselessly critical and rigorously logical.

Knowledge is obtained through three channels: perception, inference and scriptures (i.e. Agamika and Laukika). The means depend upon one's own experience, the validity of which is self-evident. The direct consciousness of an object, when the senses come in contact with it, is perception. In all perceptions we have two elements: the datum and the interpretation. But in intuitional knowledge we always have valid knowledge. It is the highest knowledge.[2] There are two different kinds of perceptions: sense perception (Indriyajanya), and emotional perception (Indriyājanya).[3]

Every act of perception has two stages: indeterminate (nirvikalpaka) where no determining attribute is observable, and determinate (savikalpaka) where the distinction between the thing and its attribute is present.[4] Determinate knowledge presupposes a change in the ultimate consciousness. This change is of the nature of differentiation of the process into the subject, the process of perception and the object perceived. The internal organ, which depends upon the soul for its power, receives and organises impressions. Even this process causes a change in it. Some modifications give a knowledge of objects, while other modifications enable us to experience emotions. The modifications of the internal organ can be classified as (1) indetermination (Samsaya),[5] (2) determination (Nischaya),[6] (3) self-consciousness (Garva),[7] and (4) remembrance (Smarana).[8]

Organic defects in the sense organs might cause a false modification of the internal organ, and in this way error may

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[1] Especially the Madhyamika school.

[2] But according to Samkara even this has got to be properly interpreted and tested by reason.

[3] Like desire, etc.

[4] E.g. The Jar and its jarness.

[5] Now it is mind.

[6] Now it is Buddhi.

[7] Now it is Self-sense or Ahamkara.

[8] Now it is Citta or Attention.—Also note: Buddhi operates in three moments, i.e. when it is born, when it exists and when it dies. But Citta endures.

arise. When the shell is mistaken for silver, this illusory silver is presented through 'Avidya,' and the cognition is aided by memory images. To attribute to an object what is different from it is 'Adhyasa.'[1] Error is of the nature of Adhyasa. The presentation of the object (the shell) is valid but the superimposition of 'silverness' on this presentation is the cause of error.

The means and objects of knowledge are more or less the same in man and animals. Mind is of the nature of a selective agent, for very often our interest determines the nature of the thought-process. Mind (manas) is also of the nature of a physical element. Men, animals and plants are essentially the same. Man has the growing power of a plant, the moving and sensing power of an animal, as well as the human characteristic of reflection, understanding and free-will (Vyutpanna-citta). The influence of Samkhya is clearly seen in the discussion on the body. The organism is supposed to have a gross body and a subtle body. The subtle body consists of the five organs of perception, the five organs of actions, five vital forms, mind and intellect.

Dream-life is contrasted with waking life in that the former is characterised by the working of the mind only, while in the waking life all the faculties can operate. In the waking life so many impressions are received by us. Those impressions which are left on the senses are stored in the mind. In the dream state those impressions that are usually buried in the mind serve as dream objects. In dreams, we cannot create anything of our own will.

Ramanuja is the other famous Acharya of South India, who, by his interpretation of the Vedanta from a sociological point of view, has earned a place amongst the teachers of India. He lived about 500 years after Samkara. He regarded the sources of knowledge as three: (1) perception, (2) inference and (3) scriptures, just as did Samkara.

Perception has two stages: indeterminate and determinate. When an object is seen for the first time, at the first instant we have merely indeterminate knowledge. The object as such can never be apprehended. When the object is qualified by some specific attributes, then only we can apprehend it. Even Yogic perception is merely sense-perception, and hence purely natural.

The help of logic is not necessary to know an object. One need not reason about it, for mind can know objects in other ways, as, for example, in intuitive knowledge when there

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[1] Adhyasa is the appearance of a thing where it is not.

is no reasoning. Imperfect and partial perception is the cause of error. Though all knowledge is of the real, generally it is imperfect and partial. In the 'shell-silver' example, we notice certain features and miss others. Error is always of the nature of omission.

Madhva, the famous exponent of the Dvaita philosophy, also took his stand by the Vedic flag and believed that his exposition came nearest to the true one. There was a tradition of dualism before Madhva's time, but the association of his name with dualism has given it an enduring place among the philosophies of India. Madhva was a native of South Canara district in South India, where he was born in 1199. His commentary on Brahma Sutra is well known.

He also accepted the three sources of knowledge: perception, inference and scripture. Every fact of apprehension is self-evident and valid. It is believed to be invalid only when some other apprehension which is valid comes to our aid.[1] But illusion is caused when we mistake similarity for the substance. Every act of illusion presupposes an objective reality, but because of its similarity to something else, it is mistaken for the other thing. The organ of knowledge is called 'saksin.' Mind (Manas), which is also material, presents impressions to it.

This brings me to the close of what has been a brief outline of the growth of psychological knowledge in ancient India. This very cursory outline that I have presented to you is an attempt to cover a period of intellectual life stretching over at least 2,500 years. If I have succeeded in conveying to you, in the meagre way that has been possible for me, some idea of the unsophisticated spirit of scientific curiosity, the intense fervour and zeal, and the outstanding psychological outlook which the ancient seers displayed in their search after Truth, then I think I shall have been amply rewarded. If, in addition, the contributions of ancient India to the growth of psychological knowledge have become evident to you, then I deem myself doubly rewarded.

The brief survey of the growth of psychology that I have outlined in the previous pages will, I trust, have already revealed the nature of the outlook that was predominant in ancient India in discussions on psychological problems. The survey

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[1] E.g. Sunrise and sunset are supposed to be two separate occurrences. Only when we apprehend further knowledge, do we come to know that the sun neither sets nor rises.

is necessarily more chronological than logical. But even so, the speculative trend of the outlook of ancient psychologists is sufficiently evident. The Indian mind seems to be peculiarly gifted in analysing psychological events, in positing psychological causes of human behaviour, and in observing peculiarities of mental characteristics and offering explanations thereto. With this inherited wealth of introspective capacity, one would expect that, in Indian soil, the growth of modern psychology would be much more prominent than in other countries.

Modern India was born with the advent of British organisations. The Western system of education, especially in the higher institutions, served as an easy means of introducing newer and necessary changes in the curricula of studies. The mother institutions in the West no sooner initiated studies in newer subjects, than the Indian universities found it comparatively easy to introduce them in their own curricula of studies. Thus, since the general awakening of the universities in the West to the importance of the study of scientific psychology, and since the evolution of experimental psychology nearly 50 years ago, momentous changes have occurred and new innovations have been introduced in the older universities of the West. Modern psychology began to be closely identified with experimental psychology. Scientific psychology began to claim a number of investigators as its votaries. Already quite a large amount of work has been done in Scientific psychology.

Let us see how it has fared in India. In other branches of learning old and time-worn ideas have frequently been dumped upon India. India has very often become genuinely interested in some fact of research many years after it had become a household concept in the West. Intellectually she has been years behind the progressive West. Not that she could very often help it. However, thanks to the general awakening of the nation, she has begun to claim her legitimate place among the nations of the world, and in the intellectual interaction of nations. It is our good fortune that the study of experimental psychology was introduced in some of our Universities just about the time when the world had begun to recognise India as a colleague in the field of intellectual progress.

There are now 17 Universities in India, many of them with a large number of constituent colleges. There are also quite a number of Training Colleges for under-graduate teachers, usually managed by the Educational Departments. There are nearly 180 institutions teaching psychology in one form or other. Except possibly in a few institutions, psychology is taught either as a part of philosophy or education. The traditional way of looking at psychology is as 'a handmaid of philosophy.' Though philosophy (specially epistemology

and logic) depends for its soundness upon a proper psychological basis, the task of psychology is much more than serving philosophy. It now has fresh demands to fulfil, fresh duties to perform on its own behalf and for other sciences. It is the duty of every educationist to recognise this.

The importance of psychology as a science was first recognised in India, in the year 1916, when the first psychological laboratory was started in Calcutta by that great Educationist Sir Asutosh Mukherjee of venerable memory. The next was started in Dacca. Then came the Mysore laboratory in 1925. Now we have laboratories in Lucknow, Lahore and Patna. The Andhra and Annamalai Universities are considering schemes to open laboratories. It is needless at this stage to point out and argue how very important it is to start courses of study in experimental psychology and open laboratories, if psychological science is to yield proper results.

It was in the year 1925 that further recognition was accorded to psychology in India. This was the year when it was included in the Indian Science Congress. In the same year the Indian Psychological Association was started with a view to 'co-ordinate psychological researches, to publish works, and to standardise the curricula of studies.' The necessity for such an association is amply borne out by the amount of work it has already turned out during the past 6 years. But it has to do more. This institution must make it its business to give proper orientation to psychological researches, because the peculiar attitude of the people to some extent determines the nature of the researches. A proper co-ordination and consequent guidance must take this into account. It is not by[1] chance that the first laboratory in experimental psychology was started in Germany, and that it should have given to the world '*gestalt*,' that France should have specialised in the study of pathological psychology, that Vienna should be zealous of psycho-analysis, that England should favour the growth of the knowledge of heredity, evolution and intelligence, and that America should, in addition to applied psychology, be partial towards the measurement of individual differences.

The inclusion of the subject in the Science Congress served as a great stimulus to original work in the field of experimental psychology. Since then as many as 222 papers have been contributed to the Congress, with a more or less steady average of 28 papers per annum. The Indian Philosophical Congress has also a place for psychology. This Congress has been working for the last 7 years, and quite a large number

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[1] Cf. J. McKeen Cattle: Psychology in America—(Address of the President of the Ninth International Congress of Psychology, given at the Yale University, New Haven).

TABLE I.

Showing the total contributions in different topics in different years.

Topics :	1925	26	27	28	29	30	31	1932	Total
General and Historical	6	3	5	3	5	4	1	5	32
Physiological	1	2	1	..	..	3	1	..	8
Sensation & Perception	5	2	4	6	6	2	2	2	29
Feeling and Emotion	1	..	1	..	3	2	2	..	9
Motor Phenomena	1	1	1	2	1	..	2	..	8
Attention and Memory	1	4	1	3	3	..	1	4	17
Social behaviour	1	1	..	3	..	2	..	..	7
Abnormal	2	..	6	6	2	7	4	7	34
Mental development and Learning.	6	1	1	..	..	1	3	4	16
Animal	1	..	..	2	..	..	1	..	4
Pedagogical	1	4	7	3	5	5	4	1	46 (Pedagogical and Tests)
Tests	3	2	3	2	3	1	2	..	
Vocational (Industrial)	..	1	2	..	1	..	1	..	5
Apparatus, Suggestions	..	3	1	..	1	1	1	..	7

TABLE II.

Showing the total contributions in different topics from different centres.

Topics :	Total	Agra	Allahabad	Benares	Bengal	Bombay	Hyderabad Dn.	Lucknow	Madras	Mysore	Punjab	Other centres
General and Historical	32	..	..	..	13	..	..	..	3	12	2	2
Physiological	8	..	..	..	6	..	..	1	..	1	..	..
Sensation & Perception	29	..	..	..	24	..	..	..	..	4	1	..
Feeling and Emotion	9	..	..	..	2	..	..	..	..	7	..	..
Motor Phenomena	8	..	..	..	7	..	..	..	..	1	..	..
Attention and Memory	17	..	..	..	12	..	..	..	..	3	2	..
Social behaviour	7	..	..	..	4	..	..	..	..	..	3	..
Abnormal	34	..	..	..	17	2	..	..	3	11	..	1
Mental development and Learning.	16	..	..	1	8	..	1	..	..	6	..	..
Animal	4	..	..	..	1	..	..	..	..	3	..	..
Pedagogical	46 (Pedagogical and Tests)	..	..	..	20	..	1	..	1	8	..	..
Tests		1	1	..	7	..	..	..	..	4	2	1
Vocational (Industrial)	5	..	..	..	3	..	..	..	..	1	1	..
Apparatus, Suggestions	7	..	..	..	4	..	..	1	..	2	..	..

of papers have been contributed to the Psychology Section of the Congress. One might have wished that with the passage of time and increased facilities, a greater amount of work should have been turned out. But the richness and variety of subjects tackled cannot but call for admiration, as the tables show.

In the order of popularity,[1] the following topics may be noted in the table :—Pedagogical, Abnormal, General and Historical, Sensation and Perception, Attention and Memory, Mental development and Learning, Feeling and Emotion, Physiological, Motor phenomena, Social behaviour, Apparatus, Suggestions, etc., Vocational (industrial included), and Animal.[2] The popularity of some of these topics is due to the fact that most of the workers are drawn from the few laboratories we have, from some of the pedagogical institutions (and Training Colleges), and from among the members of the staff of mental hospitals. That, in certain other topics (e.g. Vocational, Industrial), we should have so few contributions is significant of the fact that in ultra-academic researches especially, need precedes research.

Table II shows the topics that seem to interest workers in different parts of India. The two Provinces that stand out prominently in the table are probably more able to carry out researches, because well-equipped laboratories are easily accessible in those centres. With proper equipment and facilities, the other centres would also contribute papers in more topics than they have done up till now.

TABLE III.

Showing the total number of contributions from different centres in different years.

Centres :								
Agra	..	..	..	1	..	..	..	..
Allahabad	1	..	..	..	..	..	..	..
Benares	..	..	1	..	..	..	..	..
Bengal	20	21	22	26	13	8	13	5
Bombay	..	..	..	..	..	2	..	..
Hyderabad Dn.	..	..	..	..	..	..	1	1
Lucknow	..	..	1	..	..	..	1	..
Madras	..	..	2	2	2	1	..	..
Mysore	5	3	1	1	15	14	8	16
Punjab	1	..	5	..	..	2	2	1
Other centres	2	..	1	..	..	1	..	..
Years :—	1925	26	27	28	29	30	31	32

[1] As judged by the total contributions in each of the several topics till now.

[2] The totals for each of the topics, in the same order is :—46, 34, 32, 99, 17, 16, 9, 8, 8, 7, 7, 5, and 4.

The total of 225 papers that have been contributed to the Congress, is distributed over a number of centres and over a period of 8 years. Table III shows that there are some centres which have come recently within the fold of psychological investigators. While wishing them a hearty welcome, one may express a wish that more centres will follow suit and become actively engaged in psychological investigations.

A word may be said in regard to the proper scientific study of our ancient works on psychology. There is a widespread hope that the proper study of the Upanishads, Yoga, Tantra and other systems of Indian thought may yield fruits which may not only be contributions to our knowledge but also serve as suggestive stimuli for future work.[1] The Andhra University intends to institute a Readership in experimental psychology with special reference to Hindu Yoga.[2] During the course of the survey of the growth of psychology in ancient India, it may have been noticed how very closely some of the theories of cognition, perception, etc., approximate to some of the most modern ideas. I venture to hope that very soon the value of such studies will be appreciated.

I am tempted to make use of this occasion to point out that many who could devote some time to psychological investigations are doing insufficient work. In the course of these few years quite a number of persons must have been trained for research work. But for a whole decade we have not been able to count more than eight or ten additions to the number of investigators already engaged in research work. The founding of a laboratory suggests an enormous expenditure. But a modest beginning could be made with about Rs. 5,000. That should be sufficient to enable at least the under-graduate classes to take a course of study in experimental psychology. It might even suffice to enable research work to be done in certain fields of experimental psychology. After all, what an Indian university spends on a psychological laboratory is hardly 1/15th of the average expenditure of an American university. The disparity of conditions in these two countries cannot alone explain this huge difference.

It has often been said that Indians are essentially an introspective nation, and that the attitude they present while tackling problems of human conduct and behaviour is characteristic of the nation. Though in the intellectual internationalism of the search after Truth there can be nothing essentially nationalistic, yet it might be the destiny of one nation, by virtue of its heredity and culture, to contribute something characteristic of itself to the common fund of knowledge. The

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1 E.g. Prof. R. N. Sarma's articles on 'Psychology of Dreams in the Upanishads.'

2 I understand that the idea has now been dropped.

task before us in India is great. But a perusal of what we have already done ought to strengthen us in our belief that we can do more. The Indian Psychological Association, with its excellent organ, 'The Indian Journal of Psychology,' will, we are sure, come forward to centralise and co-ordinate the efforts of psychological investigators. The Indian universities, let us hope, will very soon become earnestly interested in the study of human behaviour and create facilities for such a study. The Indian psychologists, we may be certain, will rise to the occasion, and wrest from elusive nature truths on which the destinies of humanity depend.

Section of Psychology.

Abstracts.

1. Energy experiments and cognitive work.

C. K. Vasudeva Rao, Cocanada.

This is a continuation of the paper submitted to the Congress last year on the possibilities of 'Measuring mental work in terms of physical work'. The problem was to find out if varying grades of intellectual difficulty show differences in the fall of muscular work. Three tasks involving different grades of intellectual difficulty were tried with. 30 students of the B.T. class of the Mysore College took the tasks. Introspective account of the grades of felt difficulty of the various mental tasks were recorded. The median percentage fall in tapping and the introspective accounts were examined. Compensatory fall was found to correlate highly with the grade of felt difficulty of mental work.

The second problem was to see if the more intelligent persons show a lesser diversion of energy for a given task as compared with less intelligent persons. The coefficient of correlation between intelligence standing as determined by the scores in absurdities, analogies, reasoning, and hard opposites and the percentage fall in the output of muscular work is determined. Energy diversions during *counting backwards* yields a higher correlation with intelligence standing. The nature of mental processes in the three tasks are defined. The presumptive conclusion is that the ability to overcome previous facilitation is at least as important in cognitive work as correlate education.

2. Imitation.

B. Kuppuswamy, Mysore.

The paper reports some observations on white rats regarding the problem of imitation. The observations reveal that imitation occurs at two levels; a higher and a lower level, which could be descriptively termed *epicritic* and *protopathic* adopting Dr. Head's terminology. At the protopathic level, only ordinary instinctive movements are imitable. But imitation at the epicritic level involves 'Insight' and 'Neogenesis'.

3. 'Hunger and Escape' motivation in learning.

B. Kuppuswamy, Mysore.

The paper reports the results of the second experiment done on the problem of motivation. In 1929 a report of the first experiment was submitted to the Congress. It was then reported that 'Escape' was a better motive for learning than 'Hunger' among white rats. But there is room to think that the attention of the white rats was not concentrated on the problem since there was much rambling space. So two more groups of rats were experimented upon, under more identical conditions and the paper reports the results.

4. The Hindu view of psychological error.

T. R. Ananda Murty, Mysore.

Definition of psychological error. The wholeness of experience. The subjective (the less objective) and the objective (the more objective) aspects of it; the latter gives rise to the former. When the less objective makes a false claim of the more objective then error arises.

The treatment of the subject in Indian philosophy :—The Upanishads, the six Brahmanical systems, the Buddhistic and the Jaina systems.

Detailed study of Samkhya and Yoga. (*a*) Knowledge is determined by the bent of mind which does not apprehend all the aspects of the object. So, error which is of a nature of omission arises. (*b*) Error also is caused by non-discrimination or mistaking one thing for another.

According to Nyaya-Vaiseshika, error is purely subjective arising in the process of synthesising the impressions given in perception. When the subjective and the objective schemes disagree then we have error.

In Mimamsa, we have two schools : Prabhakar's, which says that memory which is always invalid causes error in conjunction with the perception, because, then one is mistaken for the other. Also, error may not only be due to partial knowledge but also to a failure to note a distinction between memory and presentation.

Kumarila, though agreeing with Prabhakara in details, says, that error is one of commission arising out of wrong synthesis. Adwaita Vedanta believes in the illusory nature of the objects, the objects are both real and unreal. When unreality is mistaken to the reality then error arises.

There seems to be a need of approaching the subject from a functional rather than a structural aspect.

5. Perception and ego-transformation.

J. K. SARKAR, Muzaffarpur.

The different attitudes of psychologists towards the problem of perception. Perception considered as ego-externalization. Ego-petal and ego-fugal tendencies working beneath the perceptual process. The place of ego in the process of perception. Misplacing of ego underlying the abnormalities of perception. The perceiving ego resembling the loving ego. The perceptual life corresponding to the emotional life. Perceptual and emotional identifications compared. Different forms of ego-transformation paralleling different forms of perception.

6. Reaction of high-school students on high-school subjects.

K. S. ACHARLU, Mysore.

Introduction.—Necessity and importance of the inquiry.

Plan of the experiment.—A list of nineteen subjects forming part of the Mysore S.L.C. curriculum were written on the black-board and the students were asked to give their considered opinion regarding the three subjects they liked most. They were also required to assign reasons for their preferences.

The experiment covers a range of three years and is representative of three schools and all additional subjects.

Statistical results :—

(*a*) *Student judgment.*—Whether students have used their power of judgment or have been influenced by the presence of the teacher in the class, while the experiment was being conducted, is discussed. The figures show that the students are to a great extent indifferent to the presence of the teacher in the class.

(*b*) *Selection of subjects.*—An analysis of the facts shows that students do not show a higher preference to their selected subjects.

(*c*) *Subject preferences.*—Frequencies were obtained for likes and dislikes separately.

(1) According to students' optional subjects :

The order of subject preferences by students of Mathematics, Commerce, Drawing, and other miscellaneous subjects was studied individually and in groups.

(2) According to Schools:
The order of subject preferences for schools irrespective of the subjects was studied.
(3) The above facts were studied in profile charts.
(4) Likes and dislikes of students on the whole is given.

Conclusion from the above study.—An analysis of student reasoning for subject preferences has been arrived at, which points out a need for educational guidance in selection of additional subjects, which offers suggestions in the technique of teaching, and which yields suggestions to the curriculum makers.

7. Racial differences in the trait of perseveration.

C. Ranga Char, Mysore.

In 1900, Muller and Pilzecker introduced the term 'Perseveration' from Pathology to normal Psychology and used it to indicate the tendency which every idea has, after having occurred 'to remount into consciousness spontaneously'—spontaneous in the sense that it takes place without any observable medium of association. Since then, the concept of 'Perseveration' has been broadened so as to include the phenomena of the immediate after-effect of a sensory experience. Further, the recent investigations of Lankes and others have shown that there exists a tendency for mental processes to 'perseverate'—a unitary functioning factor varying from one individual to another.

In this investigation a trial has been made to compare the preservative tendencies of Jewish and non-Jewish boys. The tests were applied to two groups of boys of about the same age from two schools, one Jewish and other non-Jewish, both attended as far as possible by boys of the same social and economic status. The tests were repeated five times and many of the disturbing factors were avoided by totally rejecting first day's performance. The reliability of the tests was obtained by correlating the sum of the second and fifth day's results with that of the third and fourth day's. The validity of the tests was established by correlating each one of the tests with the pool of all the tests. The statistical treatment of the inter-correlations showed the existence of a common factor running through these tests of perseveration.

Finally comparing the two groups it is found that the Jewish boys tend to be more perseverating than the non-Jewish boys. It is suggested that this difference is due to one of three factors:—(1) differences in intelligence, (2) differences in speed of writing, and (3) differences in heredity.

8. Intelligence and perseveration.

C. Ranga Char, Mysore.

This investigation formed part of another enquiry, 'Racial differences in the trait of Perseveration'. The object of this part was to examine the validity of the suggestion that the difference in 'intelligence might explain the observed difference in perseveration'. For this purpose, Prof. Spearman's oral tests 'A measure of "Intelligence" for use in schools' was applied to both the Jewish and the non-Jewish boys' groups. The validity of these oral tests was established by correlating the test scores with the teacher's estimates of 'intelligence'.

On comparison it was found that the Jewish boys were slightly superior to the non-Jewish boys in 'intelligence'. The results have been compared with those of similar investigations. Finally the correlations between the tests of perseverations and 'intelligence' showed that there is no relation, whatever, between 'intelligence' and 'perseveration' as measured by our tests. Furthermore, after eliminating 'intelligence' by partial correlations and applying the more rigorous test of

tetrad differences, conclusive evidence was found for the presence of some common factor pervading all these tests of perseveration. Hence it is concluded that the slight superiority of the Jewish boys in intelligence cannot explain the difference in perseveration observed between the two groups.

9. The stratification of the human mind.

J. K. Sarkar, Muzaffarpur.

The mind has a covering tendency. This tendency manifests itself in and through the different forms of the layer-formation of the mind.

The different levels of the mental attitudes are fully illustrated. It is shown that one idea may be a cover for another, one wish for its opposite wish. Fear may be a screen for wish, and wish may underlie fear. Fear may also disguise fear—the fear of fear. Love may be a cloak for death-wish. This is illustrated by the comparison between the suicide impulses of the melancholiac and the self-sacrificing tendencies of the mother.

In this paper attempts are made to disclose the hidden functional connection that exists among apparently hostile activities of the mind and also to show the different methods of reconciliation adopted by the unconscious for the purpose of disposing of the conflicts of hostile tendencies. The unconscious methods of reconciliation, as distinguished from the conscious method of regulation, are as follow :—the disguising method, the method of idealization, the processes of system-forming and synthetic functioning, etc.

10. Character trends. The problem of their measurement.

M. V. Govindaswamy, Bangalore.

Various definitions of character have been proposed from time to time by Shand, Seth, Spencer, Watson and McDougall, but from the point of view of quantitative estimation that of McDougall based on instincts seems to be satisfactory. Up till now, the nature of the tests proposed have been more or less subjective in character. Even at that they attempt to measure only one particular character trait. Moore adopted a more comprehensive plan, in that he estimated the relative strengths of different instincts in an individual by measuring the reaction time to words capable of evoking different instincts. His work had many inherent defects. By introducing a Galvanometer in this circuit, and measuring the P.G.R. under standard conditions in 50 normal individuals with known character trends, and correlating the results, the writer, working in the Psychology laboratory of the Maharaja's College, under the direction of Professor M. V. Gopalaswamy has devised a character analysis technique, the merits of which are discussed in this paper.

11. Psychological correlates of the P.G.R.

M. V. Govindaswamy, Bangalore.

There are two important schools of opinion; one of Wechsler, who maintains that 'Emotion' is the psychological correlate of the P.G.R.; and the other of Aveling, who emphasises that 'Conation' is the all important factor. The difficulty seems to be due to the confusion underlying the concept 'Emotion'. In the present paper the two schools are examined and from the results obtained from P.G.R. measurements and introspective and free association data, proofs are adduced that inhibition plays a very important part in the Galvanic Reflex.

12. The psychology of religious mysticism.

M. A. VENKATA RAO, Mysore.

The writer proposes to consider the investigation of J. H. Leuba regarding the psychology of religious mysticism.

Dr. Leuba holds that religious mysticism is a methodology to achieve certain valuable results through an alleged experience of 'Divinity'. It implies a psychic technique and a cosmic metaphysics. Leuba is of opinion that the technique has been effective for the purpose aimed at such as unification of values, production of trances and ecstasy and a sense of moral exaltation; but that it has been more or less empirical, making use of suggestion, auto-suggestion, etc., and is entirely superseded by modern psychotherapy. What is unique in it is its metaphysic and religion, but these unique elements are destined to disappear with the progress of science.

He considers the manifestations of mysticism, both physical and psychical, and maintains that they contain a large number of traits, such as hysteria, neurasthenia, etc., in common with those of various kinds of mental disorder.

Further, with regard to the mystic's sense of divine presence and guidance, Leuba refutes their transcendent causation. The Psychical occurrence is induced by auto-suggestion and other perfectly normal processes and are interpreted as divine presence in accordance with traditional theology. Leuba questions the positions of James and Pratt.

Leuba applies the same logic to ecstasy, the supreme object of mystic aspiration, and draws the same conclusion. Ecstasy is no proof of union with the divine. It can be induced by drugs or hypnotism.

In this paper the writer proposes :—(1) to examine the psychological analysis of religious mysticism offered by Leuba and point out its inadequacy. The data are not comprehensive enough, and the analysis does not touch the inner springs of mystic motivation; (2) to examine his logic, Dr. Leuba's conclusions do not follow from his premises; (3) to examine Leuba's claim that psychology dissolves the transcendent claims of mystic experience. The writer is of opinion that merely psychological exploration as such, however thorough, is incompetent to adjudge finally the objective status of mystic experience.

13. Results of tests on memory, attention, ideation, etc., in the insane.

FRANK NORONHA *and* M. V. GOVINDASWAMY, Bangalore.

Various tests were devised to test the patients' powers of attention, ideation, etc., with reference to different psychoses. While attention tests were emphasised in cases of mania, emotion ideation, and moral evaluation tests were paid greater attention in cases of melancholia and juvenile delinquents. The various tests and the different responses in the psychoses are discussed in this paper, also improvement in the patients' condition could be gathered from a more normal response to the different tests.

14. Free association tests in the insane.

FRANK NORONHA *and* M. V. GOVINDASWAMY, Bangalore.

The paper reports the results of the free association tests (Gung's 100 words) to which the patients in the Mental Hospital, Bangalore, were subjected. The more degenerate the patient's mental condition, the greater the difficulty of making him understand the test. Stereotypic answers, wandering of attention, suspicion, responses with sentences instead of words, these, seem to be the characteristic response while in a few cases valuable information as regards the psychosis could be obtained.

Presidential Address.

Congress President :—Rai Bahadur Lala Shiv Ram Kashyap, B.A., M.Sc., I.E.S.

Some Aspects of the Alpine Vegetation of the Himalaya and Tibet.

The Himalayan range, on account of its great diversity of climate at various altitudes and even in the various parts of its great length from east to west, offers a very favourable opportunity for the study of vegetation under different climatic conditions. Rising as it does from very near the level of the sea going up far beyond the snow line where the peaks are practically wholly covered with perpetual snow, thus placing a limit on the occurrence of vegetation, and extending as it does from the east where the climate is sub-tropical to the north-west where it becomes markedly temperate and in places very dry, it presents a great variety of vegetation at different parts of its course, from the magnificent sub-tropical rain forest to the scanty vegetation of alpine desert. On the contrary beyond the lofty wall of the Himalaya is the highly elevated Tibetan plateau[1] with its scanty precipitation, strong dry winds, intense insolation and severe cold, presenting a very uniform set of climatic factors, with the result that vegetation is very similar over very large areas in that region.

Although the rich flora of the Himalaya has been more or less fully studied generally from the systematic point of view yet the study of the vegetation in its various aspects has not received the attention it deserves. Even from a purely systematic point of view the intensive study of the vegetation of limited areas is sure to lead to the discovery of new forms, and a study of the flora from the ecological point of view is bound to give results of the highest importance. Not only, therefore, there is room for field work by way of observation alone but experimental investigation on the lines of the work of Bonnier in the European Alps in connection with the effect of altitude on the growth of plants would no doubt be rewarded by similar interesting results.

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[1] The Tibetan plateau near the Manasarowar Lake in Western Tibet is 15,000′ above the sea level and of course higher as we approach the neighbouring hills. It gradually falls down to the West until it is about 14,820′ at Tirthapuri and about 12,200′ at Tholing, both on the banks of the Sutlej. Beyond the Manasarowar Lake the level of the country again gradually falls towards the East. The plateau beyond the Tangla Pass is about 15,000′ and at Gyantse the level is 13,000′ above the sea.

15. Psycho-galvanic reflex in the insane.

M. V. Govindaswamy, Bangalore.

About 20 patients who could be trusted to sit still were subjected to the same test as the normal individuals referred to in the previous paper, while the results were consistently low in all mental cases, some gradations however, could be made in different disorder, while maniacs and explosive types showed very good reflex, melancholics and early dementia precox cases showed a higher reflex, and peripherial stimuli were capable of producing a greater reflex than focal stimuli in all cases.

16. The psychology of secrets.

M. N. Banerji, Calcutta.

Principles of dynamic psychology have been categorically formulated and their intimate connection with, or rather derivation from, the physiological processes explained. The mental states of doubt, forgetting, the concept of the unconscious, the two standards or ideals, one objective, experiential or of impressionability (including expectation, belief, bias), the other affective or subjective critique of response, the conscience, the sexual contribution of mental make-up have been discussed.

17. Are there instincts?

S. N. Ray, Patna.

In the first place, the so-called differences between 'Instinct' and 'Reflex' have been pointed out. Next, it has been held that these differences are more apparent than real. Taken biologically, instincts are nothing but reflexes. If we analyse an instinctive behaviour, we find that it is made of a number of reflexes which are so many elements in the mechanism through which an animal tries to maintain a state of equilibrium with its environment. Thus an animal is provided with an inherent nervous structure which enables it to adjust itself to its environment from the very start of life. Reflexes are native and unacquired responses to situations affecting the animal's sensory apparatus.

Recent psychologists have drawn our attention to the mental aspects of an instinct—its cognitive, affective and conative aspects, and have pointed out that it would be a great blunder to look upon instincts as reflexes. They have urged that for an adequate explanation of our psychic life it is essentially necessary that we must assume that man or animal to be a psycho-physical being and therefore the instincts which are psycho-physical dispositions, must be supposed to have formed the basis of all human and animal conduct. This theory however reminds us of the old faculty theory and we believe that we have no adequate reason to believe that there are so many instincts by which alone we can explain different forms of behaviour. We do not deny, like the well-known behaviourist, the fact of experience, or to do so will be suicidal, but we point out that if there is anything innate and unacquired, they are the reflexes, and besides an inherited nervous structure we have no reason to suppose a mental structure to account for a mental function. The truth is that there need be no sharp line drawn between mental activities and organic functions. Our problem is to find out how or under what circumstances certain mental functions arise along with bodily activities. To find out the 'how' is the task of every science.

18. Psycho-analysis and a psychological experiment.

H. P. Maiti, Calcutta.

19. Prābhākara's theory of cognition.

G. Hanumantha Rao, Mysore.

(1) *Nature of cognition.*—All cognition is intrinsically valid, self-evident (Svatahprāmānya).

(2) *Forms of valid cognition.*—perceptual—simple and complex, inferential, verbal, analogical, and presumptive.

(3) *Deviations from valid cognition* :—

(i) Errors due to organic causes : (*a*) A jaundiced person cognising conch as yellow-coloured; (*b*) A person suffering from bile tasting sugar as bitter; (*c*) Seeing two moons.

(ii) Errors due to subjective causes :—(*a*) Mistaking mother-of-pearl for silver. (*b*) Mistaking one direction for another. In the case of both of these, error arises on account of *what is remembered* not being distinguished from *what is really cognised*.

(iii) Errors of omission and errors of commission.

(iv) Cognition in dreams. What is only remembered is taken for something cognised.

(v) Doubt. Doubt as to whether yonder tree is a post or a person is due to conflict between two memories.

(4) *Prābhākara's analysis of cognition compared with Spearman's analysis*:—

(i) For both cognition is neogenetic.

(ii) Both account for deviations from valid cognition by the principle of retentivity.

(iii) Spearman analyses cognition into three ultimate principles; Prābhākara into five forms : complex perception, inference, analogy, verbal cognition, and presumption are subsumed by Spearman under the principles of relation-finding and correlate-finding.

20. The psychology of 'Proof'.

D. D. Shendarkar, Hyderabad (Dn.).

The origin of this inquiry was in Sir Percy Nunn's suggestion that the meaning of 'proof' is different to children of different ages. This fact he links up with the three stages :—viz., wonder, utility and system —of the development of knowledge.

Arithmetical problems were given for solution to twelve students of psychology. From their introspections, matter relevant to the nature of proof was collected. This led to the discovery that acceptance of a certain line of reasoning is not always inherent in the logical sequence of the various steps constituting the argument. The subjects were found to accept an argument on different grounds.

The following kinds of mathematical proofs were discovered :—

(i) Accepting a formula or rule because it worked in a few cases.

(ii) Accepting a new procedure from analogy.

(iii) Accepting a formula because it is familiar.

(iv) Accepting a new method after interpreting it in terms of one already known.

(v) Accepting the algebraic method as universal.

(vi) Accepting a procedure after understanding the reasoning of its derivation.

Thus, the statement that a proof can be of manifold levels is confirmed in the case of adults also.

21. The psycho-galvanic indications of consciousness of guilt.

M. V. Gopalaswami, Mysore.

In a previous paper, (*Proc. Ind. Sci. Congress*, 1929, pages 377—95), an elaborate technique for the detection of crime, has been described. The present paper reports the attempts since made for the simplification of the technique. Briefly the new technique is as follows :—

Instructions to the patient.—' Keep your eyes closed during the test, and listen to me carefully. Then *repeat verbatim* whatever I say, irrespective of the *truth* or *falsity* of the statement '.

Stimuli.—The experimenter should then proceed to make one by one, about a dozen statements, based on a thorough enquiry, regarding the personal habits, domestic affairs, income, debts, etc., of the patient; e.g.,

' My income is Rs. 20 a month.
I have three children.
I do not gamble.
I have no debts to discharge.'

After thus making a number of statements unconnected with the crime, abruptly the following statements are presented :—

' I did not commit this $\frac{\textit{murder}}{\textit{theft}}$.

I committed this $\frac{\textit{murder}}{\textit{theft}}$.

I am innocent.
I am guilty.'

Care should be taken to present the statement involving the *denial* of the offence first, so that the statement will be *true* for the innocent person, and therefore less provocative than the statement admitting the offence.

Results.—In all 27 patients have been tested for offences of theft and murder. Of these the innocence or guilt of only 6 persons have been established in Courts of Law. Taking these cases as external criteria, it was found that :

1. *guilty* persons always give higher P.G.R. for the *denial* of offence, than for the admission of the offence;
2. *innocent* persons always give higher P.G.R. for the admission of the offence, than for the denial.

22. Correlation of memory with accuracy of observation.

Suhridchandra Sinha *and* S. K. Bose, Calcutta.

The paper is based on the result of a series of experiments in which trained graduates participated as subjects. For testing accuracy of observation (*a*) ordinary picture cards showing five or six clearly distinguishable items, and (*b*) specially prepared cards with geometrical figures (complete and incomplete) were presented. In evaluating the score-values reporting of correct number of items, their positions with relation to one another and detailed description of individual items were taken into consideration. In ' memory experiment ' the subjects had to memorise (*c*) non-sense syllables, as well as (*d*) senseful materials.

Positive correlation was obtained between (*b*) and (*c*). Correlation between (*a*) and (*c*), and (*a*) and (*d*), and (*b*) and (*d*) were found to be negative.

23. Intelligence and Memory.

G. C. Chatterji *and* R. R. Kumria, Lahore.

24. Juvenile delinquency in Bangalore.

D. Sivaramiah, Bangalore.

25. Disparity in the auditary acuity.

M. N. Banerjee, Calcutta.

26. The suitability of the six-point star figure as a test of motor learning.

H. P. Maiti *and* S. S. Jalota, Calcutta.

27. The effect of gravity on the values of the Hipp Chronoscope.

S. S. Jalota, Calcutta.

28. Effect of the surrounding surface on the temporal phase of the negative after-image.

M. Samantha *and* H. P. Maiti, Calcutta.

INDEX.

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I wish to put before you some very general observations on the alpine vegetation of the Himalaya and Tibet as a result of my travels during the last 12 years or so. During this period I have had opportunities of visiting various parts of the Himalaya and have crossed the range at nine different places from the Zojila in Kashmir in the west to the Tangla at the head of the Chhumbi Valley in the east.[1]

Boundary between India and Tibet.

Although the Himalayan wall separates the southern region with its luxuriant vegetation at lower levels from the Tibetan plateau which may be termed generally a desert, yet there is no hard and fast line between the two regions so far as the vegetation is concerned in many places. Although some of the valleys like the Chhumbi Valley and the Alaknanda Valley are very rich in their flora, others like the Vishnuganga Valley in Garhwal, Chandra Valley in Lahul, even the Sutlej Valley near Shipki, and the isolated tract of Spiti, possess a type of vegetation which is essentially Tibetan (Figs. 1, 2, 3). The reason is, no doubt, the scanty precipitation and the low temperature in some cases due merely to the high altitude and in others to the nearness of high peaks with large glaciers. This difference is sometimes very marked even in neighbouring valleys where one would not expect it on account of their geographical contiguity. A good example is afforded by the Alaknanda Valley and the Vishnuganga Valley in Garhwal lying side by side and separated only by a ridge which were visited by me last August. The former possesses a rich herbaceous vegetation above 10,000 feet above the sea and was full of flowers occurring in large brilliantly coloured beds, whereas the vegetation in the latter was very scanty and presented a marked contrast on account of the absence of the colour present in the former.

Flora of Tibet.

Collections in Tibet have been made by many travellers during the last 80 years or so and in 1902 Hemsley gave a very comprehensive account of the flora of Tibet or High Asia based on these collections (*Journ. Lin. Soc.* Vol. XXXV,

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[1] The range has been crossed at the following Passes from west to east: (1) Zojila (Kashmir); (2) Shingon La (Zanskar); (3) Baralacha (Lahul); (4) Shipki La (Tibet, on the Hindustan-Tibet Road); (5) Mana Pass, and (6) Hoti Pass, near Niti Pass (both in Garhwal); (7) Kungri Bingri Pass, and (8) Lipulekh Pass (both in Kumaon), and (9) Tangla (Tibet, at the head of the Chhumbi Valley). Some of these Passes have been crossed twice or oftener. The Tangla leads to Central Tibet and all the rest lead to some part of Western Tibet including Ladak.

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1902). Since then Marquand has added a considerable number to the list from Eastern Tibet from the collections made by Kingdon Ward (*Journ. Lin. Soc.*, Vol. XLVIII, 1928). Similarly Ostenfeld and Paulsen have published the determinations of specimens collected by Sven Hedin (Sven Hedin: Southern Tibet, Vol. 6, 1921). These, with a few other papers, give us most of the information regarding the flora of Tibet. Since travelling in Tibet presents great obstacles owing to the rigorous climate of the country, difficulties of transport and provisions, etc., collections have generally been made only along the roadside and for a short period only during the year. For this reason the number of specimens collected is, even for Tibet, not large in many collections. Hemsley's comprehensive list dealing with all the collections made till then consists of 283 names of vascular plants. Excluding the species of the families Cyperaceae and the Gramineae, the number is 241. A longer stay in the country and a more extensive search would no doubt yield many more plants and although the number of plants found in Tibet must always remain very small owing to the nature of the climate yet it is certainly much larger than one would be led to conclude from the collections dealt with so far. The area included in Hemsley's paper is very extensive. He defines Tibet as 'bounded on the east by China Proper; on the south by the Himalaya Mountain: on the west by the Himalaya and Karakorum Mountains and on the north by the Keria, Toguz Daban or Kuen Luen, Altyn Tag and Nan Shan Mountains. Chinese or Eastern Turkestan in the western part and Mongolia in the eastern part, are the countries immediately to the north.' My own collection has been restricted to the southern part of Tibet and especially of Western Tibet. This part of Tibet is more elevated and far more dry and barren than central and eastern parts and the further east we go the better developed is the vegetation. A good many specimens in my collection have not been determined as yet but even then my list from a very limited area, as stated above, excluding the families Cyperaceae and Gramineae, includes 206 species as against 241 given by Hemsley from the whole of High Asia. Out of this total of 206 only 85 are found in Hemsley's list and 121 are not mentioned there. Even taking into consideration the species enumerated by Marquand from the further east and restricting ourselves only to western Tibet we still find that out of 140 species of my collection from western Tibet alone 68 are not given in Hemsley's list. Several families have not been recorded by him from this region and I have been able to add their representatives to the list, for example, Violaceae (*Viola kunawarensis*), Rubiaceae (*Galium Aparine*, *Galium pauciflorum*) and Convolvulaceæ (*Cuscuta*

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sp.). The number of species belonging to the Boraginaceae is much larger than recorded by Hemsley, being 8 against 2, and the same may be said of a number of other groups. Thus a very simple result of a more extensive study of the Flora of Western Tibet has been to increase very largely the number of plants known from that region. A complete list of the plants is issued as a supplement to this address. The term Western Tibet as used above does not include Ladak and Spiti though these parts are botanically essentially similar to Tibet proper. If they were included the number of plants would be increased still further.

A mere enumeration of species, however, gives no idea of the actual state of vegetation in any locality, or, what is worse, gives a wholly wrong impression. Although the number of species from a particular locality may be fairly large, yet it does not necessarily follow that the number of individuals would be large also and it is the number of individuals, rather than the number of species, which gives a proper idea of the vegetation of the place. In Tibet the number of individuals is very small and the soil is bare throughout the greater part of it. A good many plants are met with here and there under stones and other sheltered places, whereas, the open country is very sparsely inhabited, the plants sometimes growing at very great intervals. Near water, however, on the banks of the streams and lakes the vegetation is usually very thick and forms a dense carpet of grass and other small herbaceous flowering plants. In such places the Himalayan element is often very conspicuous. To give one example only, *Lancea tibetica* is a common plant on the Indian side at 12,000′ to 15,000′ above the sea. It is quite abundant at Kuti, 13,000′, and below the Lipulekh Pass at about 15,000′, in Kumaon. It is equally abundant in Western Tibet in moist places, at Taklakot, 13,000′, round the sacred Kailas Mountain up to 16,500′, between Tirthapuri and Dulchu, 14,500′ to 15,000′, and in Central Tibet at Dochen, 14,700′, and other similar places.

Alpine vegetation and altitude.

Tree limit is reached at about 12,000′ in the Western Himalaya (Lahul, Garhwal, Kumaon, etc.), and a little higher in the Eastern Himalaya, 12,500′ to 13,000′ (Chhumbi Valley, etc.). Beyond this level trees are replaced by shrubs which naturally differ in different parts of the range. On the east, Rhododendrons are predominant, whereas on the west Junipers and Willows are more common. There are, of course, many other woody species in addition, as *Lonicera*, *Caragana*, etc. An interesting feature of this vegetation is a tendency on the part of its components to form a

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'carpet' like their brethren in the European Alps. A 'carpet plant' in the words of Newell Arber (Plant life in Alpine Switzerland, 1910) 'is a very dwarf recumbent shrub: one might almost say a miniature tree. The plant is woody and not herbaceous. The stem is very short and buried in the soil. Just above the ground a very large number of long prostrate branches spread over a considerable area, packed closely together. The branches bear numerous little tufts of leaves and thus a green carpet of close texture, often occupying many square feet in extent, is woven over the soil.' Such carpets are very conspicuous in, among other places, the higher parts of Sikkim, for example, below Nathula at about 12,000′, where they are formed of species of *Rhododendron*, and near the source of the Alaknanda in Garhwal, formed of *Rhododendron Anthopogon* and *Salix sclerophylla* at a slightly higher level (Figs. 4 and 6). The *Rhododendron* is less than a foot high whereas the *Salix* is only 3 or 4 inches above the ground, in the latter locality.

Above this level we come to the herbaceous vegetation forming beautiful beds of large extent. The composition of such beds is naturally different in different places. They may consist merely of one or more grasses in the main or of flowering herbs of various kinds and colours, pure or mixed. These beds can be seen anywhere from the higher *margs* of Kashmir to the level spots in Sikkim in the whole range of the Himalaya. It goes without saying that local conditions regarding moisture and soil, etc., would manifest their effects by varying not only the altitude at which the various types occur but also the nature and composition of the vegetation.

Flower colour and size in alpine plants.

It has been accepted for a long time that 'in case of plants occupying a large vertical range the plant becomes practically dwarfed as its higher limit is approached. We shall, however, observe that what is lost in luxuriance of leaf and length of stem is compensated for often by increase in size and almost always by heightened colour of the flower.' (Walton: Flowers from the Upper Alps, 1869.) It is certainly true of the Himalayas that many species become dwarfed as they ascend higher and higher. Such a well-known common plant as *Chenopodium album* which may reach a height of 8 or 9 feet in the plains is reduced to an inch or two at 14,000′ or so at the adult flower-bearing stage. The second part of the above statement, however, cannot always be so clearly demonstrated. Many plants become larger as they ascend, up to a certain limit, and at the same time bear larger flowers. So much depends on the amount of moisture and shelter that mere altitude is no guide at all

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in many cases. *Anemone rivularis* was particularly observed in this respect in Garhwal. Up to about 10,000′ the plants grow bigger and many measurements showed that the flowers on the whole reached a larger size than those met with at lower levels. Occasionally large flowers were met with at lower levels also just as small flowers occurred at a higher level, but the number of large flowers at higher levels was very much larger and the absolute maximum size of the flowers was also greater at the upper limit.

Another phenomenon connected with the form and size of the flower is met with in some plants at about 10,000′ and above. This is the replacement of the flower or the fertile shoot by vegetative shoots. Its significance in connection with the alpine habit, however, is not yet known. I have noticed it in three different species. In *Euphorbia tibetica*, branches which would ordinarily end in cyathia are often replaced by vegetative shoots with ordinary leaves. It is a common enough observation in Western Tibet at about 13,000′ and was described by me at one of the meetings of the Congress in the Botany Section a few years ago. A second case is that of *Anemone rivularis* in which this abnormality is exceedingly common in the Western Himalaya at about 10,000′. Here in extreme cases the whole flower is replaced by a large tuft of green leaf-like structures. In less developed cases the carpels remain undeveloped and the sepals and stamens are modified into green leaves. In still other plants the stamens and carpels are undeveloped and the sepals are larger and more or less green in colour. The third case is that of *Rhododendron lepidotum* which possesses purple-coloured flowers. The abnormality was first seen in Sikkim at about 12,000′ where it is very common. In this case the flower is replaced by a tuft of red leaves. These examples can hardly be due to a coincidence but their significance, as stated above, is unknown.

As regards the intensity of colour it is difficult to pronounce any judgment. Species of *Potentilla* (especially *Potentilla argyrophylla*) and *Anemone* were observed but no appreciable difference could be detected. Arber says (*loc. cit.*, page 44) 'It has been shown repeatedly that the pigment which is contained in the petals and to which the colour is due increases in intensity as we pass from the plains to the Alpine zone. While this is the general rule for all colours as well as blue it does not hold good in every case.' He has also quoted figures giving the number of species with different colours of flowers. As pointed out above the enumeration of species does not always give us the true conception of the state of things. The number of species with a particular flower colour may be large yet the individuals may not be many and the flowers may not be very conspicuous. The

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percentages given (after Dr. Fisch) are, 30 per cent. white-flowered species to 27 per cent. yellow-flowered, and 19 per cent. red-flowered and 24 per cent. violet- or blue-flowered. Le Coq (quoted by Walton) after arranging Phanerogamous plants under four heads yellow, red, white and blue, observes that the yellow decreases considerably, red slightly, while the white are constant and the blue greatly increased. The flower beds at higher altitudes in the Himalaya as elsewhere show a mixture of colour yellow, red, blue, white, with intermediate tints, but in some cases there are almost pure beds of one colour belonging to one species covering large areas. In the Alaknanda Valley at about 12,000′ to 13,000′ there are beds consisting almost wholly of *Potentilla eriocarpa* or *Potentilla Sibbaldi* (both yellow), the former with medium sized solitary flowers and the latter with clusters of small flowers, covering hundreds of yards at a place. Similarly in the upper Chhumbi Valley one finds small pure patches of Primulas, especially a species with light yellow flowers (Fig. 15). Whenever there is a mixture, the yellow seems to predominate both as regards the number of individuals as well as the conspicuousness of colour. Red and blue are both well represented, the former usually more so than the latter but the white is not so conspicuous.

A few examples may be given showing the predominant species with their flower colour:—

(A) Top of the Baralacha Pass (Lahul), 16,200′, July and August, 1928:—

1.	*Saxifraga sp.*	...	Yellow.
2.	*Ranunculus sp.*	...	Yellow.
3.	*Sedum sp.*	...	Yellow.
4.	*Potentilla sp.*	. .	Yellow.
5.	*Draba sp.*	...	Yellow.
6.	*Primula sp.*	...	Blue.
7.	*Pedicularis sp.*	...	Red.
8.	Crucifer	...	White.
9.	Caryophyllaceous	..	White.

The first three give the characteristic colour to large areas.

(B) Top of Shingon La (Zanskar) about 17,000′, August, 1928:—

1.	*Corydalis sp.*	...	Yellow.
2.	*Corydalis sp.*	...	Yellow.
3.	*Saxifraga sp.*	...	Yellow.
4.	*Pedicularis sp.*	...	Yellow.
5.	*Draba sp.*	...	Yellow
6.	*Potentilla sp.*	...	Yellow
7.	*Gentiana sp.*	...	Blue.
8.	*Delphinium sp.*	...	Blue.

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9.	*Polygonum affine* ...	Red.
10.	*Oxyria digyna* ...	Red.
11.	*Epilobium sp.* ...	Pink.
12.	*Composite* ...	White.

Yellow was the predominant colour.

(C) Chakra-tirath, near the source of the Alaknanda, (Garhwal), about 13,000′ to 14,000′, August, 1931:—

1.	*Potentilla argyrophylla*	Yellow to scarlet with all the intermediate stages, various shades of orange, etc.
2.	*Potentilla Sibbaldi* ...	Yellow.
3.	*Potentilla eriocarpa* ...	Yellow.
4.	*Saxifraga flagellaris* ...	Yellow.
5.	*Ranunculus hirtellus* ...	Yellow.
6.	*Polygonum affine* ...	Red.
7.	*Oxyria digyna* ...	Red.
8.	*Saxifraga Stracheyi* ...	Pink. (Flowers nearly over).
9.	*Sedum sp.* ...	Red.
10.	*Geranium Wallichianum.*	Blue.
11.	*Primula sp.* ...	Blue.
12.	Boraginaceous ...	Purple.

Yellow colour was most predominant and red also quite conspicuous. *Potentilla argyrophylla* was particularly abundant in all the various shades from bright yellow through various grades of orange to brilliant red.

(D) Head of Chhumbi Valley, a few miles before Phari, about 14,500′, July to August, 1930:—

1.	*Ranunculus sp.* ...	Yellow.
2.	*Primula sp.* ...	Yellow.
3.	*Corydalis sp.* ...	Yellow.
4.	*Corydalis sp.* ...	Blue.
5.	*Aster sp.* ...	Blue.
6.	Labiate ..	Blue.
7.	*Polygonum viviparum*	Pink to red.
8.	*Epilobium sp.* ...	Pink.
9.	*Geranium refractum* ...	Pink to red.
10.	*Pedicularis sp.* ...	Red.
11.	*Leontopodium alpinum*	White.
12.	*Anaphalis sp.* ...	White.
13.	A few more yellow and white Compositae.	

The beds showed a mixture of the various colours. The predominant yellow colour was due to No. 1, red colour due to

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Veeriah, M.
Vengadamma, M. K.
Venkatachalam, C.
Venkataraman, E.
Venkataramanan, K.
Venkataramanaiya, M. L.
Venkataramanaswamy, S. V.
Venkataramiah, H. S.
Venugopalan, V.
Viswanathan, M.
Visweswaraiya, S.
Vydhyanathan, V. R.

Y

Yajnanarayana, P.

RULES.

INDIAN SCIENCE CONGRESS.

1. The name of the Association shall be the Indian Science Congress, and its object shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including:

(a) the holding and management of funds and property,
(b) the acquisition of rights and privileges necessary or convenient for the object of the Association,
(c) the management, development, improvement, disposal, and sale of all and any parts of the property of the Association.

2. There shall be an Executive Committee which shall carry on the administrative work of the Congress and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

3. The Executive Committee shall consist of the President, the Retiring President, the two General Secretaries, and the Treasurer (who shall be the Treasurer of the Asiatic Society of Bengal for the time being) of the Congress, the General Secretary of the Asiatic Society of Bengal for the time being, and five Permanent Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Executive Committee shall co-opt as members at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

4. The Executive Committee shall have full power to transact all business in case of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

5. There shall be a General Committee which shall consist of all Permanent Members of the Congress and such Sessional Members as have held office in the Congress.

Officers of the Congress for the purpose of this Rule shall be: the Members of the Executive Committee and the Presidents and Recorders of Sections.

6. The General Committee shall meet at least once during each Session of the Congress, preferably in the middle of the Session.

7. There shall be a Council which shall consist of the Members of the Executive Committee, the Past Presidents of the Congress present in India, the Sectional Presidents for the ensuing Session, and, in addition, five Permanent Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

8. The Executive Committee shall consult the Council on matters of general scientific import and policy.

9. There shall be a President who shall be nominated by the Executive Committee, and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

10. There shall be two General Secretaries who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

11. Each General Secretary shall hold office till the termination of the fifth Session of the Congress following the confirmation of his appointment, and shall be eligible for re-appointment.

12. In the event of a vacancy amongst the General Secretaries occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary for the period up to the termination of the next Session of the Congress

13. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

14. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

15. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

16. For the purpose of scientific deliberation during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee.

17. There shall be Sectional Presidents and Sectional Recorders who shall be appointed by the Executive Committee.

18. There shall be Sectional Committees which shall consist of the following two officers :—

(*a*) The President of the Section (Convener),
(*b*) The Recorder of the Section,

and, in addition, of the following members :—

(*c*) All Permanent Members of the Congress who have been President or Recorder of the Section concerned,
(*d*) Two members elected by the General Committee at its Annual Meeting during the Session of the Congress.

A Sectional Committee may co-opt two additional Permanent Members of the Congress of whom one at least shall be resident in the locality in which the ensuing Session of the Congress is to be held.

In the absence of the President of any Section from any of its meetings, the most senior member of the Sectional Committee present shall take the Chair.

The Sectional Committees shall meet on the opening day of each Session of the Congress and as often as may be necessary during the Session of the Congress.

Each Sectional Committee shall in its meetings during the Session of each Congress :—

(*a*) nominate a Sectional President and a Sectional Recorder for next year's Session of the Congress for the consideration of the Executive Committee,
(*b*) determine the detailed arrangements of the Sectional meetings,
(*c*) select the papers to be read and discussed,
(*d*) delete by a two-thirds' majority any abstract from final publication in the Proceedings,
(*e*) determine the contents of the Sectional record in the Proceedings.

19. (*a*) Any paper submitted for reading at the Session of the Congress shall be forwarded to the President of the Section concerned so as to reach him not later than a date to be fixed from time to time by the Executive Committee.

(*b*) Any paper submitted for reading at the Session of the Congress shall be accompanied by an abstract in triplicate.

(*c*) Any paper submitted for reading at the Session of the Congress shall be refereed by the Sectional President or by some person or persons appointed by him. Decisions with regard to acceptance or refusal of any paper for submission to the Sectional Committee shall be final and all reports confidential.

(*d*) No published paper shall be accepted.

20 The Congress shall consist of four classes of members :—

(*a*) *Permanent Members.*
Annual subscription Rs. 10/-.
The subscription shall become due on the 1st of February of each year and shall only be effective as a payment for Permanent Membership subscription if paid before the 15th of July of the year.

(*b*) *Sessional Members.*
Subscription Rs. 10/- per session.

(*c*) *Associate Members.*
Subscription Rs. 5/- per session.

(*d*) *Student Members.*
Subscription Rs. 2/- per session.

(A Student Member must be duly certified by the head of his institution to be a *bona fide* student.)

Permanent and Sessional Members shall have the right of contributing papers for reading at the Session of the Congress and to receive free of charge all publications relating to the Session for which they are members.

Associate and Student Members shall have the right of contributing papers for reading at the Session of the Congress provided they have been communicated by a Permanent Member.

21. Any Permanent Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150/-.

22. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Indian Science Congress :—

(*i*) Proposals for additions to and alterations in the existing Rules of the Indian Science Congress may be placed at any time before the General Committee by the Executive Committee.

(*ii*) (*a*) Proposals for additions to and alterations in the existing Rules by any Permanent Member of the Congress shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(*b*) One of the General Secretaries shall circulate such proposals to all Permanent Members of the Congress at least one full month before the meeting of the General Committee.

(*c*) Any amendments to the proposals shall be sent by any Permanent Member of the Congress to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.

(*d*) The proposals together with any amendments, shall be brought up before the meeting of the General Committee at its Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds' majority of the constituent Members present at the meeting.

(*Adopted the 5th January*, 1931.)

Nos. 7, 8 and 9, and blue to Nos. 5 and 6. Some of them were found in pure beds. All the colours were about equally conspicuous.

In Tibet there is practically never any massed colour effect. There are sometimes isolated patches of individual plants or of small clusters of plants showing a particular colour. Species of *Corydalis*, *Aconitum*, *Sedum*, *Pedicularis*, *Meconopsis*, etc., are examples. *Ranunculus aquatilis* with its white or cream flowers with a yellow centre, however, occurs in large patches in water and is the famous lotus of the holy lake Manasarowar. *Arenaria musciformis*, wherever found, forms conspicuous cushions, scattered over large areas, easily seen from a distance on account of its fairly large white flowers (Fig. 8). Similarly *Astragalus melanostachys* with its blue flowers forms even more conspicuous tufts and covers even larger areas in Central Tibet. *Stellera Chamaejasme* is another conspicuous plant in some localities with its tufts of branches and peculiar coloured flowers which are white above (inside) and purple below (outside). As pointed out by the writer (*Journ. Ind. Bot. Soc.*, Vol. IX, No. 4, 1930) the colour of the flower in this plant is not yellow as stated by so many authorities. The mistake has no doubt arisen owing to the fact that the flower becomes yellow on drying and even leaves a yellow stain on the mounting paper.

Near water, however, the vegetation forms dense carpets and here again the yellow *Ranunculus Cymbalariae* is the commonest plant. *Potentilla anserina* (yellow) is also fairly common and *Polygonum sibiricum* (pink) is abundant. *Lancea tibetica* with its purple flowers is met with here and there. Many other plants grow in smaller numbers. The predominant colour, however, is again yellow. Over very large areas in Tibet we find only scattered tufts of grass or of some other flowering plant without any sign of any other colour but green or grey of the vegetative shoots.

A curious feature in connection with the colour of flowers is the occurrence in some plants of very dark almost or quite black colour in Tibet. The flower of *Clematis orientalis* is usually described as yellow or purple, but very dark, almost black flowers are very common in Western and Central Tibet. In some places, Taklakot in Western Tibet (13,000′) and near Khangma on the road to Gyantse in Central Tibet (about 13,000′) the writer found flowers of this colour only in all the plants. Yellow-flowered plants were met with at Tirthapuri in Western Tibet (14,800′). Similarly the glands on the involucre of *Euphorbia tibetica* which is abundantly met with in Ladak and Western Tibet are black. Black colour is exceedingly unusual in plants and its occurrence in two Tibetan species is noteworthy.

A large number of alpine plants in the Eastern Himalayas have pendulous flowers directed downwards or at least horizontally. This is no doubt an adaptation against rain. Some of them though not actually pendulous at first become pendulous by the force of the rain drops. This phenomenon is shown conspicuously by many species of *Primula, Polygonum, Geranium* and *Anemone* (Fig. 5). In other cases the flowers close immediately on the approach of the moist weather. This is shown conspicuously by the species of *Anaphalis*. Pendulous flowers are not so common in the Western Himalayas as they are on the Eastern side, apparently associated with a lower rainfall. This phenomenon is well known in the European Alps also.

Composition of alpine plants.

Certain families are much better represented in alpine regions than others. Families like the Compositae, Leguminosae and Gramineae would naturally include a large number of alpine plants on account of their large size, but the same cannot be said of others like the Primulaceae, Gentianaceae and Polygonaceae which have a disproportionately large share in alpine vegetation. Again, some genera like *Astragalus, Oxytropis, Arenaria, Draba, Potentilla, Saussurea* and *Polygonum* are very largely represented in the flora of the higher altitudes. This distribution would lead to the conclusion that a tendency towards adaptation to a cold and dry habitat is not due to haphazard variation in isolated species but is more deep-seated in circles of wider affinity and becomes manifest during the course of evolution in all the branches of the evolving group—the genera of a family or the species of a genus. I am afraid I cannot pause to follow this subject further.

Alpine plants in the plains.

Bonnier's experiments on the changes produced in alpine plants when cultivated in the plains and *vice versa* are well known. He has been able to show that in many cases plants from one locality when grown in the other tend to acquire the characters of the plants of the second locality. So far as I know no such experiments have been tried with Himalayan plants. A number of seeds from the Western Himalaya and Tibet were germinated by the writer at Lahore three years ago. Some of them died after a short time. Among those which have survived there is a species of *Ephedra*, apparently *E. vulgaris*. The seeds of this plant were collected in Zanskar at about 12,000′ in August, 1928. They were sown in October the same year and germinated readily after a fortnight and went on growing for a little more than a month. Then they became dormant till next February and resumed the growth towards the end of that month when winter was over. Winter is the resting season in Zanskar

and the seedlings stuck to the habit of the parent plants in the first year. Since then, however, they have found that winter at Lahore is the more favourable season for growth and summer is the resting time. Growth is quite active in winter now and it stops during the hot months of summer —an undoubted adaptation to new conditions. The plants are still under observation and interesting results may be expected.

Habit of Tibetan Plants.

A good deal has already been said about this part of the subject by various writers. In my Presidential address to the Indian Botanical Society at Benares, published in the Journal of the *Ind. Bot. Soc.*, Vol. IV, Nos. 9 and 10, 1925, I said something about the subject. The number of annuals in Tibet is very small just as their size is small owing to the short growing season, i.e., summer. The perennials have a long tap root and an underground woody root-stock which remains alive in winter while the aerial parts are killed. Another common feature is the small size of the leaves which are often thick or hairy. Some of the commonest plants are spinous. As already stated the plants are met with scattered on the surface with large bare intervals between them except when the plants are growing on the banks of a stream or lake and sometimes when they are growing under stones getting sufficient protection against the desiccating effect of the dry cold winds. Several stolon-bearing plants are common in moist places both in Western and Central Tibet. They strike the eye on account of their long slender arms reaching out in all directions. *Potentilla anserina*, *Saxifraga flagellaris* and another undetermined species met with at Dochen (14,700′) in Central Tibet, are examples. The most characteristic feature, however, of the Tibetan vegetation which strikes the eye is the cushion habit of many of the species which in its less developed degree takes the form of tufts. In many cases the cushions are exceedingly compact so that from the outside there is hardly any trace of branches and even of leaves. There are of course intermediate grades between loose tufts and compact cushions. Among the latter may be mentioned *Thylacospermum rupifragrum*, *Arenaria musciformis*, *Androsace sp.*, *Astragalus sp.*, and *Caragana pygmaea*. Of these *Thylacospermum*, *Arenaria* and *Astragalus* form the densest cushions. *Androsace* is very compact when growing in the soil but when the plants are taken out of the soil the branches usually become loosened and the cushion breaks up. Among the tufted plants there are many species of *Astragalus* and *Oxytropis*, *Stellera Chamaejasme*, *Artemisia sp.*, *Urtica hyperborea* and some species of *Caragana*, etc. *Astragalus*

melanostachys and *Urtica hyperborea* are the commonest tufted plants in Central Tibet.

The cushion habit is a very efficient adaptation on the part of the plants against the intensely cold winds of the country. The compact branches and the small, often minute, leaves are effectively protected in this way. Any projecting branch would be killed in a very short time. The annual growth naturally is very slight (Figs. 7–13).

This cushion habit is also met with occasionally on the south side of the Himalaya (apart from the dry valleys mentioned before) but usually it is not so well developed. In some cases this is not so much due to the effect of cold as to grazing by sheep and goats. The accompanying photograph of a species of *Fraxinus* illustrates this. This species ordinarily is a tree with the usual tree habit but owing to excessive grazing when it grows on the roadside it forms a dense cushion and sometimes a part of it may be able to grow into an erect branched tree whereas the rest of it forms a cushion lower down (Figs. 14 and 15). Perhaps the cushion habit in Tibet also, in some cases, may have something to do with grazing by innumerable herds of yaks, sheep and goats, but there is no doubt that in the main it is an adaptation against the intensely dry cold winds.

Another interesting problem is the occurrence of small-leaved and markedly xerophilous plants and very broad-leaved plants side by side. This is the case in some parts of Central Tibet where *Astragalus melanostachys* is found growing side by side with a broad leaved erect *Senecio* and *Urtica hyperborea* (Fig. 16). Similarly the very broad-leaved *Senecio Ligularia* grows in the open near Phari at 14,500′. The tall *Rheum nobile* with its five feet or more of height and large broad leaves and bracts grows side by side with *Saussurea gossypiphora*, only a few inches above the ground and closely covered with a dense wool of hairs, on the Jelepla and Nathula in Sikkim above 14,000′ (Figs. 17 and 18). The explanation probably lies in the fact that the broad-leaved stems exist only in summer and are not present during the unfavourable period of the year. It also illustrates clearly what has been demonstrated by Maximov and others that drought resistance does not depend on leaf surface or the rate at which water is transpired and that it is more a property of the protoplasm itself (The Journal of Ecology: Vol. XIX, page 281, 1930). A wide field of research lies open in this direction in connection with the study of structure of the various parts of alpine plants in relation to the environment.

Maximum altitude for vegetation.

Hemsley states that according to the figures given in his paper 'nearly half of the Tibetan species in our enumera-

tion have been collected at 16,000′ and upwards. Whether these figures are very exact or not they go to prove that there is no altitudinal limit to flowering plants except perpetual snow.' There can be no question about the truth of this conclusion. He has, however, recorded only six species which were known to occur above 18,000′. The Mount Everest Expedition has found plants at 20,000′ or even higher. Mr. Wollaston of that expedition mentions species of *Leonotopodium* and grasses at 20,000′ and *Arenaria musciformis* on 20,100′ (The Reconnaissance, 1921). I collected no less than 18 species between 18,500′ and 18,600′ on the Damala which was crossed during the circumambulation of the Holy Kailas Mountain and it is probable that more than 31 other species also could grow at this altitude as these were found on the way to the Pass between 16,500′ and 18,600′. The following is a list of the species met with on the Pass between 18,500′ and 18,600′.

1. *Ranunculus pulchellus* C. A. Mey.
2. *Ranunculus lobatus* Jacq.
3. *Draba alpina* L.
4. *Cochlearia scapiflora* H.f. et T.
5. *Braya alpina* Sternb. et Hoppe.
6. *Thylacospermum rupifragum* Schrenk.
7. *Arenaria musciformis* Wall.
8. *Stellaria decumbens* Edgw. var. *pulvinata*.
9. *Astragalus sp.* (probably *A. confertus* Benth.)[1]
10. *Potentilla fruticosa* var. *ochreata*.
11. *Potentilla nivea* L.
12. *Sedum asiaticum* DC. var. *Wallichianum*.
13. *Senecio* (*Cremanthodium*) *goringensis* Hemsl.
14. *Saussurea stoliczkai* Clarke.
15. *Allardia glabra* DC.
16. *Leontopodium alpinum* Cass.
17. *Androsace Poissonii* Knuth.
18. *Lloydia serotina* Reichb.

and some grasses.

Some facts of peculiar distribution.

Although there is nothing unusual in what is described below in connection with the distribution of plants, a few cases of peculiar distribution of certain cushion plants are mentioned as interesting. *Acantholimon lycopodioides* forms large dense cushions and has spinous-tipped leaves. It is common in Ladak and Zanskar but was not met with beyond the Baralacha Pass towards the east. *Thylacospermum*

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[1] Two species were collected on the way to Damala, 16,500′ to 18,600′. One of these is mentioned in my diary as occurring at the top.

rupifragrum is very common in Ladak and Western Tibet at about 15,000′ and above. The Phirtse La Pass leading from the Lingti sumdo to Zanskar at some distance below the top, especially on the Lingti side, has numerous cushions of this plant scattered over a large area. This place shows the best development of the plant so far seen by the writer. The plant of course is common in other places in Western Tibet also, scattered about on the ground or growing among stones. The writer photographed a plant growing on the Damala Pass at 18,500′ among stones. It can hardly be distinguished from the stones in the photograph. It becomes scarce further east at 15,000′ to 16,000′ and below. *Arenaria musciformis* is common both in Western and Central Tibet. Its dense cushions are met with scattered over large areas and the white flowers are very conspicuous from long distances as already mentioned above. This was one of the plants found on the top of the Damala at 18,600′. *Androsace* sp. are also very common in Western and Central Tibet. They require further examination for their full determination. A very compact species of *Astragalus* has been seen only in Central Tibet. It has not been found possible to name it so far. Some of these cushion plants belonging to different species grow not only side by side but actually into one another so that it is impossible to separate them without breaking the cushions. This is particularly true of species of *Androsace* and *Arenaria musciformis* (Fig. 10).

Origin of the Tibetan Flora.

Some people have given Central Asia great importance in connection with the origin of the alpine plants. Arber states (*loc. cit.*, page 305-306), 'It has been urged that Central Asia was the origin of the Alpine Flora.' Hemsley says, 'No arguments are required to prove that the Tibetan is a derived flora; that is to say, derived since the tertiary period; and its composition is so largely Himalayan that there can be little doubt as to its origin.' This would seem to imply that Tibet was bare at some time when the Himalaya was covered with vegetation. The high altitude of Tibet makes this very improbable. The upheaval of the Himalaya and Tibet must have been simultaneous and the vegetation also must have developed simultaneously. Marquand very recently has remarked (*loc. cit.*) 'Material available now makes it quite clear that one homogeneous flora extends from Sikkim to Eastern Tibet and the whole of the Eastern Himalayas, South Eastern Tibet and Western Szechuen as well as the upper portions of Yunnan should be considered as one botanical area.' Central Tibet is not sharply marked off from Eastern Tibet with its more luxuriant vegetation on the one hand and

from the higher and wilder Western Tibet with its scanty vegetation on the other. The latter possesses a much more rigorous climate but it cannot be said that the Flora of Western Tibet has had a different origin. It possesses a smaller number of plants, more highly adapted to more unfavourable conditions than their eastern relatives. The flora of Western Tibet must naturally be poorer as fewer plants can be expected to adapt themselves to extreme conditions.

Considering all the data it would be more in accordance with facts to say that the floras of the Himalaya and Tibet and Western China have had a common origin and differentiation gradually took place as the Himalaya and the Tibetan plateau gradually rose from the sea level to become the highest region in the world.

FIG. 1.—Vegetation at Kaljawar, Vishnuganga Valley, Garhwal, about 14,000′. 1931. *Urtica hyperborea* in the foreground, *Caragana pygmaea* in the distance.

FIG. 2.—Bushes at Kalapani below Lipulekh Pass, Kumaon, about 12,000′ 1926.
Mostly *Juniperus* sp

FIG. 3.—Tufts of grass in Chandra Valley, Lahul, about 14,000′ 1928.

FIG. 4.—*Rhododendron* sp. forming a carpet Below Nathula, Sikkim, 13,000′ 1930.

FIG. 5.—*Primula* sp. Head of Chhumbi Valley, before Phari, 14,500′. 1930.

FIG. 6.—Carpet plants at Chakra tirath, Alaknanda Valley, Garhwal, about 13,000′. 1931.

Salix sclerophylla in the foreground; *Rhododendron Anthopogon* in the distance.

FIG. 7 —*Thylacospermum rupifragum* on Lachalung Pass, Ladak, 16,500′ 1920

FIG. 8.—*Arenaria musciformis*, Dochen, Central Tibet, 14,700′. 1930.

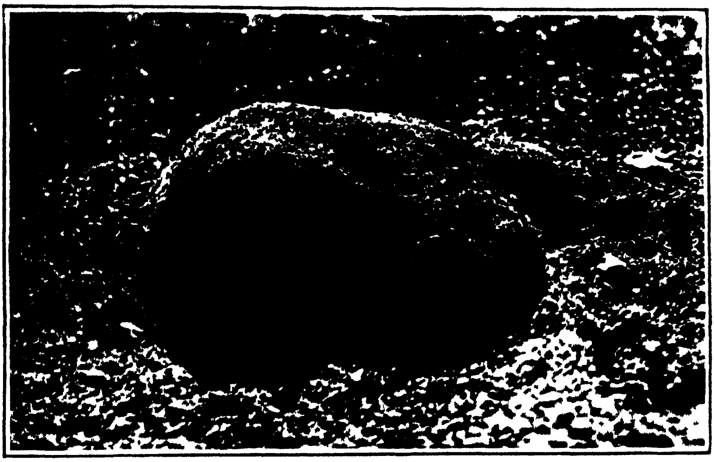

FIG. 9.—*Astragalus* sp. Dochen, Central Tibet, 14,700′. 1930.

FIG. 10.—*Androsace* sp. (Light coloured, in nature dark green); *Arenaria musciformis* (dark coloured, in nature light green) Dochen, Central Tibet, 14,700′. 1930.

FIG. 11 – *Acantholimon lycopodioides* (large), Ladak, about 13,000 1920 The second small plant is *Arenaria musciformis.*

FIG. 12.—Clump vegetation in Central Tibet, 14,700′. 1930.

FIG. 14.—*Fraxinus* sp. Cushion formation due to excessive grazing. Vishnuganga Valley, about 12,000′. 1931.

FIG. 16.—*Astragalus melanostachys* (right) and *Senecio* sp (left) Central Tibet about 14,000'. 1930.

FIG. 17.—*Saussurea gossypiphora* Two plants Nathula, Sikkim, 14,700' 1930.

FIG. 18.—*Rheum nobile.* Nathula, Sikkim, 14,700′. 1930.

APPENDIX.

List of Plants in the Herbarium of the Botany Department, Government College, Lahore, collected by Professor S. R. Kashyap beyond the main Himalayan range.

The plants given in the following list have been collected during the last 12 years at various places beyound the Himalaya. The country includes Western and Central Tibet proper as well as Spiti, Zanskar, Rupshu, and Ladak proper, which are not a part of Tibet in the political sense but are similar to it geographically. The climate as well as the people are similar to those in Tibet proper.

Collections in Tibet have been made by many travellers during the last 80 years or so and in 1902 Hemsley gave a very comprehensive account of the flora of Tibet or High Asia based on these collections (*Journ. Linn. Soc.*, Vol. XXXV, 1902). Since then Marquand has added a considerable number to the list from Eastern Tibet from the collections made by Kingdom Ward (*Journ. Linn. Soc.*, Vol. XLVIII, 1928) Similarly Ostenfeld and Paulsen have published the determinations of specimens collected by Sven Hedin (Sven Hedin: *Southern Tibet*, Vol. 6, 1921). A very full list of the flora of Ladak has been given by Stewart in the *Bulletin of the Torrey Botanical Club*, Vol. 43, 1916 and 1917. The present list includes a large number of plants not given in any of the papers mentioned above from this region.

Many of the specimens collected have been determined by the writer himself and practically all of them have been compared at the Herbarium of the Royal Botanic Garden, Calcutta, by Pt. Amar Chand Joshi, M.Sc, lately Demonstrator of Botany, Punjab University, Lahore, and at present Assistant Professor of Botany at the Benares Hindu University. A few from the neighbourhood of the Baralacha Pass collected in 1919 were determined at the Royal Botanic Gardens, Kew, and the thanks of the writer are due to the authorities there for the kindness.

A few words may be said regarding the route followed during the various years in the different parts of Tibet. The journeys described below were made during the months of June, July, and August, mostly during July and August, of the various years.

The writer crossed the main Himalaya for the first time in 1919. He started from Chamba and crossed the Sach Pass into Pangi, went up the Chanderbhaga through Lahul up to Kyelang and thence up the Bhaga to its source at the Baralacha Pass, 16,200 ft. in altitude, and then went about 2 stages beyond to the Lingti plain. The collection of plants that year was badly damaged as one of the pack ponies was almost drowned in the 'Suan' stream near Una on the way back. The packet of plants was thrown into the water and was rescued with considerable difficulty. Most of these plants were determined at the Royal Botanic Gardens, Kew, as already stated. On the way back he returned through Kulu, crossing the Rotang Pass.

In 1920, he again started from Chamba, crossed the Kugti Pass into Lahul and thence again crossing the Baralacha Pass passed through Rupshu and Ladak and crossing the Zoji La Pass came out into the Kashmir Valley. During this journey he was accompanied by Dr. B. Sahni, now Professor of Botany at the Lucknow University, and part of the collection from Ladak was made by him.

In 1922, accompanied by 4 members of the staff of the Khalsa College, Amritsar, he started from Almora and going up the Kali through Bians crossed the Lipulekh Pass, 16,780 ft., into Western Tibet proper. After

visiting the holy lakes, Manasarowar and Rakastal, and going round the holy mountain Kailas, the party travelled westwards to Gyanima and thence to the large monastery at Tholing, 12,200 ft. above the sea on the banks of the Sutlej. From there the party crossed the Mana Pass, 17,890 ft. above the sea level, back to India, coming out at Badrinath, the famous place of Hindu pilgrimage.

In 1923, he started from Simla and went along the Hindustan-Tibet Road up the Sutlej and crossed the boundary into Tibet just before Shipki and went for a short distance beyond. On the way back some unfrequented lateral ridges were crossed, finally reaching Rampur, the capital of the Bashahr State and crossing the ridge into the Tons Valley reached Chakrata.

In 1926, he again visited Western Tibet and a very large part of the collection from Western Tibet in the Herbarium was made during this journey. This journey was financed by the Punjab University for which the thanks of the writer are due to the University. The start was made again from Almora but this time the writer went through the Darma Valley and near its upper end crossed the Joling Kang Pass into the Kali Valley reaching the village of Kuti. From there he went down the stream a short distance until the path met the road followed in 1922 through Bians and thence up to the Lipulekh Pass and beyond. The Manasarowar and Kailas region was again visited and from there he went westwards again, this time visiting the unfrequented monasteries at Dulchu and Tirthapuri. From the latter place he went to Gyanima and thence returned to India by the Kungri Bingri Pass, 18,300 ft. high, coming out at Milam, 11,160 ft., in Johar. During these days Mr. H. Ruttledge, I.C.S., then Collector of Almora, was on an official visit to Western Tibet and his party and the writer travelled together for many days. They crossed the Lipulekh Pass together and were together during the visit to Rakastal and Manasarowar and the circumambulation of the Kailas Mountain. From Darchin at the foot of the Kailas Mr. Ruttledge and his party went straight to Gyanima while the writer as stated above visited Dulchu and Tirthapuri and then returned to Gyanima by a different route. From Gyanima to Milam they were also together.[1]

In 1928, the writer was accompanied by a few students of the Botany Department of the Lahore Government College and the route of 1919 was followed up to the Baralacha Pass. From here the party went down the Chander, which is the second branch of the Chanderbhaga, to the Lake Chanderdal, and thence crossed the Manh Pass into Spiti, reaching Losar, the first village in this isolated territory. On the way back they again passed by the Baralacha Pass to the Lingti Plain and thence crossed the Phirtse la, about 17,000 ft., into Zanskar. After spending a few days there they came out again into Lahul via the Shingon la.

In 1929, the starting point was Darjeeling and for the first few stages the writer was accompanied by his advanced Botany students

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[1] Mr. Ruttledge, speaking of the march from Gyanima to the Kungri-bingri Pass, writes (The Geographical Journal: Vol. LXXI, 1928, page 438): 'Here, as everywhere else on these plains, almost the only vegetation seen, apart from the occasional grass, was the cushion-like *Caragana pygmaea*, for which name I am indebted to my friend Rai Shiv Ram Kashyap Sahib, Professor of Botany at the Government College, Lahore, an indefatigable traveller who accompanied us all the way from the Lipu.' This statement requires a slight modification. From the Lipulekh Pass we were together up to the foot of the Kailas and during the 'parikarma' round it, but I left the party at Darchan at the foot of the holy mountain on the 26th August and went alone to Dulchu and Tirthapuri and met them again five days later at Gyanima to which place they had proceeded by a direct and shorter route, followed by the writer in 1922.

as had been usually the case in former years also. Passing through Gangtok, the capital of Sikkim, he crossed the Jelepla, 14,390 ft., into the Chhumbi Valley and crossing the Tangla Pass at its head, 15,200 ft., followed the route to Gyantse. Chhumbi Valley is on the south side of the Himalaya but is politically under Tibet and the country beyond Phari, the last village in this Valley, is designated in this paper as Central Tibet. On the way back the same route was followed but from the Chhumbi Valley the route to Gangtok crossing the Nathula, 14,750 ft., was taken.

In 1930, the start was again made from Darjeeling and after passing through Sikkim to the Chhumbi Valley, via the Nathula, Gyantse was again reached. On the way back in Sikkim a part of the Lachen Valley was visited.

The plants collected from Pangi, Lahul, the Sutlej Valley along the Hindustan-Tibet Road up to the Tibetan Frontier and the Chhumbi Valley are not included in this list. A list of Lahul plants will be found in a paper by Aitchison in the *Journal of the Linnean Society, London*, Vol. 10, No. 42, 1868.

In 1931, the writer visited the upper valleys in Garhwal near the source of the Ganges, *i.e.*, the Valleys of the Alaknanda and the Vishnuganga and just crossed the Hoti Pass, about 17,000 ft., at the head of the Niti or Vishnuganga Valley, into Tibet, but since no plants were collected in Tibet itself and the two valleys mentioned above are on the south of the Himalayas, the plants collected in these valleys also are not mentioned in the list.

A reference to the collection of plants given here will also be found in the accompanying Presidential Address by the writer to the Indian Science Congress held at Bangalore in January, 1932, and also some notes on the geography of Western Tibet are contained in the writer's paper on 'Some geographical observations in Western Tibet' published in the *Journal and Proceedings of the Asiatic Society of Bengal (New Series)*, Vol. XXV, 1929, No. 1, issued 11th March, 1930.

RANUNCULACEAE.

Clematis orientalis, *L.*

Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926, flowers almost black; Tirthapuri, 14,500 ft., W. Tibet, July, 1926, flowers yellow.

Clematis orientalis, *L.* var. **acutifolia.**

Samada, 14,100 ft., C. Tibet, 27th July, 1929.

Thalictrum rutaefolium, *H.f. and T.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Thalictrum saniculaeforme, *DC.*

Ladak, 1920.

Thalictrum foetidum, *L.*

Ladak, 1920; Losar (Spiti) to Chandradal (Lahul), 14,000 ft., Spiti, 16th Aug., 1928.

Ranunculus aquatilis, *L.*

Manasarowar, 15,000 ft., W. Tibet, July, 1926; below Dulchu, 15,000 ft., W. Tibet, July, 1926; Tirthapuri to Dulchu, 14,500–15,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929; Tuna, 14,700 ft., C. Tibet, July, 1930.

Ranunculus Cymbalariae, *Pursh.*

Ladak, 1920; Lingti plain, 14,000 ft., Rupshu, Aug., 1928; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928; Taklakot, 13,000 ft., W.

ft., Rupshu, July, 1919; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Draba lasiophylla, *Royle.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922; Jiu (Manasarowar), 15,000 ft., W. Tibet, July, 1926; Rakastal, 15,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, 1926.

Draba fladnitzensis, *Wulf.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Draba setosa, *Royle.*

Kinlung to Sarchu, 14,500 ft., Rupshu, 20th Aug., 1928; Kinlung, 15,000 ft., Rupshu, July, 1919; Baralacha Pass both sides, 16,000 ft., Rupshu, Aug., 1928; Spiti, 14,000 ft., Aug., 1928; Camp to Losar, 15,000 ft., Spiti, 14th Aug., 1928.

Draba setosa, *Royle.* var. **stylosa.**

Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928.

Draba cachemirica, *Gandoger.*

Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926.

Cochlearia himalaica, *H.f. and T.*

Kinlung, 15,000 ft., Rupshu, 20th Aug., 1928; Kinlung to Sarchu, 14,500 ft., Rupshu, 20th Aug., 1928; Tuna, 14,700 ft., C. Tibet, Aug., 1930.

Cochlearia scapiflora, *H.f. and T.*

Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930.

Malcolmia africana, *R. Br.*

Ladak, 1920.

Sisymbrium rupestre, *Edgew.*

Ladak, 1920.

Sisymbrium humile, *C. A. Mey.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Manasarowar, 15,000 ft., W. Tibet, 1922.

Sisymbrium Sophia, *Linn.*

Ladak, 1920.

Sisymbrium Columnae, *Jacq.*

Taklakot, 13,000 ft., W. Tibet, July, 1926.

Christolea crassifolia, *Cambess.*

Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Pala, about 14,000 ft., W. Tibet, July, 1926, Manasarowar, 15,000 ft., W. Tibet, 1922.

Braya alpina, *Sternb. and Hoppe.*

Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Braya tibetica, *H.f. and T.*

Ladak, 1920; Kinlung, 14,500 ft., Rupshu, July, 1919; Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928.

Capsella Thomsoni, *H.f.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Lepidium latifolium, *Linn.* var. **platycarpum.**

Ladak, 1920.

Lepidium ruderale, *Linn.*

Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926

Dilophia salsa, *Thoms.*

Ladak, 1920; Lingti plains, 14,000 ft., Rupshu, 21st Aug., 1928

Tauscheria lasiocarpa, *DC.*

Spiti, 14,000 ft., Aug., 1928.

Chorispora Sabulosa, *Camb.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Rungung, 14,000 ft., W. Tibet, July, 1926; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W Tibet, July, 1926.

VIOLACEAE.

Viola Kunawarensis, *Royle.*

Tirthapuri to Dulchu, 14,500–15,000 ft, W Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926

CARYOPHYLLEAE

Dianthus anatolicus, *Boiss*

Kinlung, 15,000 ft., Rupshu, July, 1919; Lingti plains, 14,000 ft., Rupshu, 14th Aug., 1928.

Dianthus angulatus, *Royle.*

Ladak, 1920

Silene Moorcroftiana, *Wall.*

Ladak, 1920; Kinlung, 15,000 ft, Rupshu, July, 1919; Tirthapuri, 14,500 ft., W. Tibet, July, 1926

Silene caespitella, *Williams.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Camp to Losar, 14,000 ft., Spiti, 14th Aug, 1928

Silene, sp

Ladak, 1920.

Lychnis apetala, *Linn*

Ladak, 1920.

Cerastium trigynum, *L*

Baralacha Pass, 16,000 ft., Rupshu, 19th Aug., 1928; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928

Stellaria graminea, *Linn.*

Kinlung, 15,000 ft., Rupshu, July, 1919; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Stellaria decumbens, *Edgew.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Kinlung to Sarchu, 14,500 ft., Rupshu, 20th Aug., 1928; Baralacha Pass, 16,000 ft., Rupshu, July, 1928.

Stellaria decumbens, *Edgew.* var. **pulvinata.**
Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Arenaria foliosa, *Royle.*
Ladak, 1920.

Arenaria festucoides, *Benth.*
Manasarowar region, 15,000 ft., W. Tibet, July, 1926.

Arenaria musciformis, *Wall.*
Ladak, 1920; Barkha, 15,000 ft., W. Tibet, July, 1922, Pala, about 14,000 ft., W. Tibet, July, 1926; Damala, 18,600 ft., Kailas Round, W. Tibet, July, 1926; Manasarowar, 15,000 ft., W. Tibet, July, 1926; Samada, 14,100 ft., C. Tibet, July, 1929; Dochen, 14,700 ft., C. Tibet, July, 1929.

Arenaria holosteoides, *Camb.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Thylacospermum rupifragrum, *Schrenk.*
Ladak, 1920; Common in Zanskar and Rupshu, 15,000–16,000 ft.; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926; Lachalung Pass, 16,500 ft., Ladak, 1920; near Phirtsela, 15,000 ft., Aug., 1928; Manasarowar, 15,000 ft., W. Tibet, July, 1926.

Polycarpaea corymbosa, *Lamk.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

TAMARISCINEAE.

Myricaria germanica, *Desv.* var. **prostrata.**
Kinlung, 15,000 ft., Rupshu, July, 1919; W. Tibet, 1922; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Zanskar, Aug., 1928.

Myricaria elegans, *Royle*
W. Tibet.

MALVACEAE

Hibiscus Trionum, *L.*
Ladak, 1920.

LINEAE.

Linum perenne, *Linn.*
Saugong, 13,400 ft., C. Tibet, July, 1930.

Linum usitatissimum, *Linn*
Ladak, 1920.

GERANIACEAE.

Biebersteinia emodi, *Jaub and Spach.*
Kinlung, 15,000 ft., Rupshu, July, 1919 and 20th Aug., 1928.

Geranium pratense, *Linn.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Geranium collinum, *Steph.*
Ladak, 1920; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928.

Geranium Wallichianum, *Sw.*
Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928.

Geranium Grevilleanum, *Wall.*
Ladak, 1920.

RUTACEAE.

Peganum Harmala, *Linn.*
Ladak, 1920.

LEGUMINOSAE.

Thermopsis inflata, *Camb.*
Rakastal, 15,000 ft., W. Tibet, July, 1926; above Dochen (Dug la) 16,000 ft., C. Tibet, July, 1930; Kala, 14,600 ft., C. Tibet, 26th July, 1929.

Caragana pygmaea, *DC.*
Ladak, 1920; Kinlung, 15,000 ft., Rupshu, July, 1919; Lingti plain, 14,000 ft., Rupshu, Aug., 1928; W Tibet, 1922; Rungung, 14,000 ft., W. Tibet, July, 1926.

Caragana crassicaulis, *Benth.*
I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Caragana cuneata, *Baker*
Ladak, 1920.

Caragana spinosa, *DC.* var. **tibetica.**
Samada, 14,100 ft., C. Tibet, July, 1930.

Caragana, sp.
Gyantse, C. Tibet, Aug., 1930.

Astragalus Heydei, *Baker.*
Way to Tirthapuri, about 14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, 1926.

Astragalus tribulifolius, *Benth.*
Manasarowar, 15,000 ft., W. Tibet, July, 1926; Rungung, 14,000 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926.

Astragalus confertus, *Benth.*
I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Rungung, 14,000 ft., W. Tibet, July, 1926.

Astragalus strictus, *Grah.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Astragalus melanostachys, *Benth.*
Dochen, 14,700 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, July, 1929; Gyantse Road, C. Tibet, July, 1930; very common in Central Tibet on the Phari Gyantse road.

Astragalus Munroi, *Benth.*
Ladak, 1920.

Astragalus acaulis, *Baker.*
Kinlung to Sarchu, 14,500 ft., Rupshu, 1928; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928; Gyantse Road, C. Tibet, Aug., 1930.

Astragalus malacophyllus, *Benth.*
W. Tibet, July, 1926.

Astragalus nivalis, *Kar and Kir.*

Ladak, 1920; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928.

Astragalus, sp.

Gyantse Road, near Dochen, 14,700 ft., C. Tibet, July, 1930. Kala 14,600 ft., C. Tibet, July, 1930. Forms very dense cushions.

Oxytropis lapponica, *Gaud.* var. **Jacquemontiana.**

Lingti Plain, 14,000 ft., Rupshu, 21st Aug., 1928; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Oxytropis glacialis, *Benth.*

Kinlung to Sarchu, 14,500 ft., Rupshu, 20th Aug., 1928; Kinlung, 15,000 ft., Rupshu, July, 1919; Baralacha Pass, 16,000 ft., Rupshu, 19th Aug., 1928; Taklakot, 13,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928; Dochen, 14,700 ft., C. Tibet, 7th Aug., 1930.

Oxytropis mollis, *Royle.*

Ladak, 1920; Baralacha Pass, 16,000 ft., Rupshu, 19th Aug., 1928; Kinlung to Sarchu, 14,500 ft., Rupshu, 20th Aug., 1928; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928.

Oxytropis Thomsoni, *Benth.*

Khangma, 13,900 ft., C. Tibet, July, 1930; Gyantse Road, C. Tibet, Aug., 1930.

Oxytropis tatarica, *Camb.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Oxytropis microphylla, *DC.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, July, 1926; Taklakot, 13,000 ft., W. Tibet, July, 1926; Rakastal, 15,000 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Rungung, 14,000 ft., W. Tibet, July, 1926; Dochen, 14,700 ft., C. Tibet, July, 1929

Oxytropis diffusa, *Led.*

Ladak, 1920.

Oxytropis hystrix, *C. A. May.*

Ladak, 1920.

Oxytropis complicata, *Prain.*

Taklakot, 13,000 ft., W. Tibet, July, 1926.

Oxytropis sericopetala, *Prain.*

Tuna, 14,700 ft., C. Tibet, July, 1929; Rakastal, 15,000 ft., W. Tibet, July, 1926; Darchan, 15,000 ft., W. Tibet, July, 1926.

Stracheya tibetica, *Benth.*

Barkha Plain, 15,000 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1929 and 1930.

Cicer soongaricum, *Steph.*

Ladak, 1920; Camp to Losar, 14,000 ft., Spiti, 14th Aug., 1928

Pisum arvense, *L.*

Taklakot, 13,000 ft., W. Tibet, July, 1926; Losar, 13,000 ft., Spiti, Aug., 1928; Gyantse Road, C. Tibet, Aug., 1930.

Sophora Moorcroftiana, *Benth.*

Khangma, 13,900 ft., C. Tibet, July, 1930; Kala, 14,600 ft., C. Tibet, 26th July, 1929.

ROSACEAE.

Potentilla Sibbaldi, *Haller.*

Gyantse Road, C. Tibet, July, 1930.

Potentilla fruticosa, *Linn.* var **pumila.**

Kinlung, 15,000 ft., Rupshu, July, 1919; Spiti, near Losar, 14,000 ft., Aug., 1928.

Potentilla fruticosa, *Linn.* var. **ochreata.**

Gaurikund, 18,500 ft. Kailas Round, W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Potentilla fulgens, *Wall.*

Gyantse, 13,000 ft., C. Tibet, 22nd July, 1929.

Potentilla anserina, *Linn.*

Taklakot, 13,000 ft., W. Tibet, July, 1926: Rungung, 14,000 ft., W. Tibet, July, 1926; Barkha Plain, 15,000 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, Aug., 1930.

Potentilla Leschenaultiana, *Ser.* var. **bannehalensis.**

Camp to Losar, 15,000 ft., Spiti, Aug., 1928.

Potentilla Griffithii, *H.f.*

Gyantse Road, C. Tibet, Aug., 1930.

Potentilla peduncularis, *Don.*

Gyantse Road, C. Tibet, Aug., 1930; Gyantse, 13,000 ft., C. Tibet, July, 1929.

Potentilla bifurca, *Linn.*

Ladak, 1920; Kinlung, 15,000 ft., Rupshu, Aug., 1928; Manasarowar, 15,000 ft., W. Tibet, 1922; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Jin, 15,000 ft., W. Tibet, July, 1926; Camp to Losar, 14,000 ft., Spiti, Aug., 1928; Gyantse 13,000 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, July, 1930.

Potentilla multifida, *Linn.*

Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928; Taklakot, 13,000 ft., W. Tibet, July, 1926; Rungung, 14,000 ft., W. Tibet, July, 1926; Pala, about 14,000 ft., W. Tibet, July, 1926; Camp to Losar, 15,000 ft., Spiti, Aug., 1928.

Potentilla multifida, *Linn.* var. **ornithopoda.**

Ladak, 1920.

Potentilla multifida, *Linn.* var. **Saundersiana.**

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Potentilla sericea, *Linn.* var. **genuina.**

Taklakot, 13,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Camp to Losar, 15,000 ft., Spiti, Aug., 1928; Shingon la, 16,000 ft., Zanskar, Aug., 1928.

Potentilla argyrophylla, *Wall.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Baralacha Pass, 16,000 ft., Rupshu, July, 1928.

Potentilla nivea, *Linn.*

Kinlung, 15,000 ft., Rupshu, July, 1919; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Potentilla Margheritae, *Prain.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Jiu, 15,000 ft., W. Tibet, July, 1926.

SAXIFRAGEAE.

Saxifraga sibirica, *Linn.*

Kinlung, 15,000 ft., Rupshu, July, 1919.

Saxifraga Hirculus, *Linn.* var. **hirculoides.**

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Saxifraga imbricata, *Royle.*

Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928; Manasarowar, 15,000 ft., W. Tibet, 1922.

Saxifraga flagellaris, *Willd.*

Baralacha Pass, 16,000 ft., Rupshu July, 1928; Manasarowar, 15,000 ft., W. Tibet, 1922.

Saxifraga Stracheyi, *H.f. and T.*

Spiti, 14,000 ft., Aug., 1928.

Parnassia ovata, *Ledeb.*

Phari, 14,300 ft., C. Tibet, 24th July, 1929.

Ribes orientale, *Poir.*

Ladak, 1920; Saugong, 13,400 ft., C. Tibet, July, 1930.

CRASSULACEAE.

Sedum himalense, *Don.*

Camp to Losar, 14,000 ft., Spiti, Aug., 1928.

Sedum asiaticum, *DC.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Sedum asiaticum, *DC.* var. **Wallichianum.**

Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, 1926; Rakastal, 15,000 ft., W. Tibet, July, 1926.

Sedum linearifolium, *Royle.*

Tuna, 14,700 ft., C. Tibet, Aug., 1930.

Sedum Ewersii, *Ledeb.*

Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Sedum Hobsoni, *Prain.*

Ladak, 1920.

Sedum Smithii, *Hamet.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926.

Sempervivum acuminatum, *Dcne.* var. **genuinum.**

Tirthapuri, 11,500 ft., W. Tibet, July, 1926; Camp to Losar, 15,000 ft., Spiti, Aug., 1928.

HALORAGEAE.

Hippuris vulgaris, *Linn.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Tuna, 14,700 ft., C. Tibet, July, 1930.

Myriophyllum verticillatum, *Linn.*

Manasarowar 15,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Kala Lake, 14,600 ft., C. Tibet, Aug., 1929.

ONAGRARIEAE.

Epilobium latifolium, *Linn.*

Kimlung, 15,000 ft., Rupshu, 1919; Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928.

Epilobium roseum, *Schreb.*

Ladak, 1920.

Epilobium alpinum, *Linn.*

Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Epilobium Clarkeanum, *Hau.*

Taklakot, 13,000 ft., W. Tibet, July, 1926.

UMBELLIFERAL.

Trachydium Roylei, *Lindl.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Bupleurum falcatum, *Linn.* var. **nigro.**

Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926; Spiti, 14,000 ft., July, 1926.

Carum Carui, *Linn.*

Camp to Losar, 15,000 ft., Spiti, Aug., 1928.

Sium latijugum, *C. B. Clarke.*

Ladak, 1920.

Pimpinella curvata, *C. B. Clarke.*

Gyantse Road, C. Tibet, July, 1930.

Prangos pabularia, *Lindl.*

Ladak, 1920.

Pleurospermum Govanianum, *DC.*

Phari, 14,300 ft., C. Tibet, July, 1929.

Pleurospermum Candollii, *Benth.*

Baralacha Pass, 16,000 ft., Rupshu, Aug., 1928

Ferula Jaeschkeana, *Vatke.*

Ladak, 1920.

Peucedanum Dhana, *Ham.*

Ladak, 1920.

Peucedanum Malcolmi, *Hemsl. et Pears.*

Gyantse Road, C. Tibet, July, 1930.

CAPRIFOLIACEAE.

Lonicera spinosa, *Jacq.*
Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926; Saugong, 13,400 ft., C. Tibet, July, 1930.

RUBIACEAE.

Hedyotis stipulata, *Br.*
Ladak, 1920; Karzia, 13,500 ft., Zanskar, Aug., 1928.

Galium pauciflorum, *Bunge.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Galium aparine, *L.*
Taklakat, 13,000 ft., W. Tibet, July, 1926.

DIPSACEAE.

Morina polyphylla, *Wall.*
Ladak, 1920.

COMPOSITAE.

Aster Heterochaeta, *Benth.*
Way to Gyantse, C. Tibet, July, 1929.

Aster molliusculus, *Wall.*
Way to Gyantse, C. Tibet, July, 1929.

Aster praetermissus, *J. R. Dru.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Erigeron asteroides, *Roxb.*
Khaugnia, 13,900 ft., C. Tibet, Aug., 1930.

Erigeron andryaloides, *Benth.*
Ladak, 1920; Spiti, 14,500 ft., 13th Aug., 1928; Camp to Losar, Spiti, 14,000 ft., 14th Aug., 1928.

Erigeron alpinus, *Linn.*
Ladak, 1920; Kinlung, 15,000 ft., Rupshu, July, 1919.

Erigeron alpinus, *Linn.* var. **multicaulis.**
Ladak, 1920.

Microglossa albescens, *C. B. Clarke.*
Saugong, 13,400 ft., C. Tibet, July, 1930.

Leontopodium alpinum, *Cass.*
Ladak, 1920; Kinlung, 14,500 ft., Rupshu, July, 1919; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Dama la, 18,600 ft., Kailas Round, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Rakastal, 15,000 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930; Phari, 14,300 ft., and Dochen, 14,700 ft., C. Tibet, July, 1929.

Anaphalis cuneifolia, *H.f. and T.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Camp to Losar, 15,000 ft., Spiti, Aug., 1928.

Inula obtusifolia, *Kerner.*
Ladak, 1920.

Inula grandiflora, *Willd.*
Khangma, 13,900 ft., C. Tibet, July, 1929.

Inula rhizocephaloides, *C. B. Clarke.*
Ladak, 1920.

Allardia glabra, *Dcne.*
Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, 1926; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Allardia tomentosa, *Dcne.*
Baralacha, 16,000 ft., Rupshu, July, 1919; Kinlung 15,000 ft., Rupshu, July, 1919; Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Chrysanthemum tibeticum, *H.f. and T.*
Ladak, 1920.

Chrysanthemum Richteria, *Benth.*
Ladak, 1920; Kinlung, 15,000 ft., Rupshu, 20th Aug., 1928.

Chrysanthemum (Tanacetum) tenuifolium, *Gay.*
Kinlung, 15,000 ft., Rupshu, 20th Aug., 1928; Spiti, 14,000 ft., Aug., 1928.

• **Chrysanthemum (Tanacetum) senecionis,** *Gay.*
Phirtse la, 16,000 ft., Zanskar, Aug., 1928.

Tanacetum tibeticum, *Tef. and Sh.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Artemisia salsoloides, *Willd.*
Ladak, 1920; Rakastal, 15,000 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929.

Artemisia Dracunculus, *Linn.*
Tuna, 14,700 ft., C. Tibet, July, 1930.

Artemisia stricta, *Edgew.*
Phari, 14,300 ft., C. Tibet, July, 1929.

Artemisia maritima, *Linn.*
Lingti plain, 14,500 ft., Rupshu, 20th Aug., 1928; Losar, 13,000 ft., Spiti, 14th Aug., 1928.

Artemisia Tournefortiana, *Reichb.*
Ladak, 1920; Gyantse Road, C. Tibet, July, 1930; Samada, 14,100 ft., C. Tibet, July, 1929.

Artemisia vestita, *Wall.*
Ladak, 1920; Camp to Losar, Spiti, 14,000 ft., 14th Aug., 1928; Khangma 13,900 ft., C. Tibet, July, 1930; Saugong, 13,400 ft., C. Tibet. 29th July, 1929.

Artemisia laciniata, *Willd.*
Ladak, 1920.

Artemisia Campbellii, *H.f. and T.*
Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926; Taklakot, 13,000 ft., W. Tibet, July, 1926; Khangma, 13,900 ft., C. Tibet, July, 1930; Gyantse Road, C. Tibet, July, 1930.

Artemisia Stracheyi, *H.f. and T.*

Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Samada, 14,100 ft., C. Tibet, July, 1930.

Artemisia minor, *Jacquem.*

Ladak, 1920; Kinlung, 15,000 ft., Rupshu, July, 1919; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Rakastal, 15,000 ft., W. Tibet, July, 1926.

Artemisia Sieversiana, *Willd.*

Ladak, 1920; Camp to Losar, 15,000 ft., Spiti, Aug., 1928; Losar, Spiti, 14,000 ft., 1928.

Artemisia arenaria, *DC.*

Manasarowar, 15,000 ft., W. Tibet, July, 1926; Khangma, 13,900 ft., C. Tibet, July, 1930.

Artemisia frigida, *Willd.*

Kala, 14,600 ft., C Tibet, July, 1930; Tuna, 14,700 ft., C. Tibet, July, 1930; Khangma, 13,900 ft., C. Tibet, July, 1930; Way to Gyantse, C. Tibet, July, 1929.

Lactuca orientalis, *Boiss.*

Ladak, 1920.

Lactuca tatarica, *C. A. Mey.*

Ladak, 1920.

Lactuca decipiens, *H.f.*

Ladak, 1920.

Senecio chrysanthemoides, *DC.*

Saugong, 13,400 ft., C. Tibet, July, 1930; Gyantse Road, C. Tibet, Aug., 1930. There is only one poor specimen in the herbarium.

Senecio tenuifolius, *Burm.*

Taklakot, 13,000 ft., W. Tibet, July, 1926; Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Senecio Ligularia, *H.f.*

Saugong, 13,400 ft., C. Tibet, July, 1930.

Senecio (Cremanthodium) gorigensis, *Hem.*

Ladak, 1920; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926.

Cousinia Thomsoni, *Clarke.*

Pala, about 14,000 ft., W. Tibet, July, 1926.

Saussurea obvallata, *Wall.*

Below Shingon la, 16,000 ft., Zanskar, Aug., 1928; Saugong, 14,000 ft., C. Tibet, July, 1930.

Saussurea bracteata, *Dcne.*

Ladak, 1920.

Saussurea Stoliczkai, *Clarke.*

Camp to Dama la, 16,500–18,600 ft., Kailas Round, W. Tibet, 1926; Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Manh Pass, 15,000 ft., Spiti, 13th Aug., 1928; Gyantse Road, C. Tibet, Aug., 1930.

Saussurea glanduligera, *Schultz.*

Ladak, 1920; Rakastal, 15,000 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929.

Saussurea sacra, *Edgew.*

On Lipu Lekh Pass, 16,000 ft., way to W. Tibet, 1922.

Saussurea sorocephala, *H.f. and T.*

Ladak, 1920; Camp to Dama la, 16,500–18,600 ft., Kailas Round, W. Tibet, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Saussurea Kingii, *Jrdr.*

Manh Pass, 15,000 ft., Spiti, 13th Aug., 1928.

Crepis flexuosa, *Ledeb.*

Taklakot, 13,000 ft., W. Tibet, July, 1926.

Crepis glomerata, *Dcne.*

Way to Gyantse, C. Tibet, July, 1929.

Taraxacum officinale, *Wigg.*

Ladak, 1920; Camp to Dama la, 16,500–18,600 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929; Camp, Spiti, 14,000 ft., Aug., 1928.

Taraxacum sp.

Ladak, 1920.

Scorzonera divaricata, *Turcz.*

Ladak, 1920; Camp to Losar, Spiti, 14,000 ft., 14th Aug., 1928.

CAMPANULACEAE.

Codonopsis ovata, *Benth.*

Ladak, 1920.

PLUMBAGINEAE.

Acantholimon lycopodioides, *Boiss.*

Ladak, 1920; Zanskar, 14,000 ft., Aug., 1928.

PRIMULACEAE.

Primula tibetica, *Wall.*

Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Darchan, 15,000 ft., W. Tibet, July, 1926; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Primula sp.

Below Shingon la, 16,000 ft., Zanskar, Aug., 1928.

Primula sp.

Darchan, 16,000 ft., W. Tibet, July, 1926.

Primula sp.

Ladak, 1920.

Primula sp.

On the way to Gyantse, C. Tibet, July, 1929.

Androsace villosa, *Linn.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922; Barkha Plain, 15,000 ft., W. Tibet, July, 1926.

Androsace Poissonii, *Knuth.*
Damala, 18,600 ft., W. Tibet, 23rd July, 1926 (with **Arenaria musciformis**).

Androsace sp.
Barkha Plain, 15,000 ft., July, 1926.

Androsace sp.
Samada, 14,100 ft., C. Tibet, July, 1929.

Glaux maritima, *Linn.*
Barkha Plain, 15,000 ft., W. Tibet, July, 1926.

APOCYNACEAE.

Apocynum venetum, *Linn.*
Ladak, 1920.

ASCLEPIADEAE.

Cynanchum acutum, *Linn.*
Ladak, 1920.

GENTIANEAE.

Gentiana Moorcroftiana, *Wall.*
Spiti, 14,000 ft., Aug., 1928.

Gentiana humilis, *Steven.*
Darchan, 15,000 ft., W. Tibet, July, 1926; Taklakot, 13,000 ft., W. Tibet, July, 1926.

Gentiana nubigena, *Edgew.*
Shingon la, 17,000 ft., Zanskar, Aug., 1928.

Gentiana dentosa, *Fries.* var. **Stracheyi.**
Ladak, 1920.

Gentiana pharica, *Burkill.*
Way to Gyantse, C. Tibet, July, 1929.

Gentiana tianschanica, *Rupr.*
Zanskar, 15,000 ft., Aug., 1928.

Pleurogyne Thomsoni, *Clarke.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Lingti Plain, 14,000 ft., Rupshu, Aug., 1928; Taklakot, 13,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Swertia Thomsoni, *C. B. Clarke.*
Ladak, 1920.

BORAGINEAE.

Lindelofia Benthami, *H.f.*
Manasarowar, 15,000 ft., W. Tibet, 1922.

Paracaryum asperum, *Stodes.*
Ladak, 1920.

Eritrichium strictum, *Dcne.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Lingti Plain, 14,000 ft., Rupshu, Aug., 1928; Manasarowar, W. Tibet, 1922; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Eritrichium Munroi, *Clarke.*

Manasarowar, W. Tibet, 1922; Rungung, 14,000 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930.

Eritrichium basifixum, *Clarke.*

Beyond Baralacha Pass, Rupshu, Aug., 1928.

Microula Benthami (M. tibetica, *Max.*), *Clarke.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926.

Microula Sikkimensis, *Hem.*

Saugong, 13,400 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, 1929.

Lycopsis arvensis, *Linn.*

Saugong, 13,400 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, 1929.

Myosotis sylvatica, *Hoffm.*

Ladak, 1920.

Arnebia tibetica, *Kurz.*

Manasarowar, 15,000 ft., W. Tibet, 1922.

Macrotomia perennis, *Boiss.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Manasarowar, 15,000 ft., W. Tibet, 1922; Camp to Losar, Spiti, 14,000 ft., Aug., 1928; Karzah, 13,000 ft., Zanskar, Aug., 1928.

CONVOLVULACEAE.

Cuscuta sp.

Manasarowar, 15,000 ft., W. Tibet, 1922; Zanskar, 14,000 ft., Aug., 1928.

SOLANACEAE.

Physochlaina praealta, *H.f.*

Manasarowar, 15,000 ft., W. Tibet, 1922; Taklakot, 13,000 ft., W. Tibet, July, 1926; common in Western Tibet.

Hyoscyamus pusillus, *Linn.*

Ladak, 1920.

SCROPHULARINEAE.

Scrophularia lucida, *L.*

Ladak, 1920.

Scrophularia dentata, *Royle.*

Manasarowar, 15,000 ft., W. Tibet, 1922, and July, 1926; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Scrophularia scabiosaefolia, *Benth.*

Ladak, 1920.

Lancea tibetica, *H.f. and T.*

Ladak, 1920; I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Taklakot, 13,000 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Dochen, 14,700 ft., C. Tibet, Aug., 1930.

Picrorhiza Kurrooa, *Royle.*
Ladak, 1920; below Shingon la, 15,000 ft., Zanskar, Aug., 1928.

Veronica Anagalis, *L.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Veronica biloba, *L.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Taklakot, 13,000 ft., W. Tibet, July, 1926; Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Pedicularis globifera, *H.f.*
Phari, 14,300 ft., C. Tibet, July, 1929.

Pedicularis verticillata, *L.*
Ladak, 1920.

Pedicularis bicornuta, *Klotzsch.*
Below Shingon la, 15,500 ft., Zanskar, Aug., 1928.

Pedicularis siphonantha, *Don.*
Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922.

Pedicularis rhinanthoides, *Schrenk.*
Spiti, 14,000 ft., Aug., 1928.

Pedicularis Collata, *Prain.*
I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926.

Pedicularis longiflora, *Rud.*
Ladak, 1920.

OROBANCHACEAE.

Orobanche cernua, *Loeff.*
Ladak, 1920.

LABIATAE.

Elsholtzia eriostachya, *Benth.*
Spiti, 14,000 ft., Aug., 1928; Gyantse, 13,000 ft., C. Tibet, July, 1929.

Elsholtzia strobilifera, *Benth.*
Gyantse, 13,000 ft., C. Tibet, July, 1929.

Mentha sylvestris, *L.* var. **incana.**
Ladak, 1920.

Thymus Serpyllum, *L.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Perowskia abrotanoides, *Kiril.*
Ladak, 1920.

Nepeta eriostachya, *Benth.*
Camp to Losar, Spiti, 14,000 ft., Aug., 1928.

Nepeta discolor, *Benth.*
Ladak, 1920.

Nepeta longibracteata, *Benth.*
Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926.

Nepeta glutinosa, *Benth.*

Lingti Plain, 14,000 ft., Rupshu, 20th Aug., 1928.

Nepeta pharica, *Prain.*

Above Dochen, about 15,000 ft., C. Tibet, July, 1929.

Dracocephalum heterophyllum, *Benth.*

Ladak, 1920; Manasarowar, 15,000 ft., W. Tibet, 1922; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Tuna, 14,700 ft., C. Tibet, July, 1930; Way to Gyantse, C. Tibet, July, 1929; Red Image Gorge, C. Tibet, July, 1930.

Scutellaria Heydei, *Hk.f.*

Ladak, 1920.

Stachys tibetica, *Vatke.*

Ladak, 1920.

Phlomis rotata, *Benth.*

Khangma, 13,900 ft., C. Tibet, Aug., 1929; Red Image Gorge, C. Tibet, July, 1930.

PLANTAGINEAE.

Plantago lanceolata, *L.*

Sarchu, 14,000 ft., Rupshu, July, 1919.

Plantago tibetica, *H.f. and T.*

Taklakot, 13,000 ft., W. Tibet, July, 1926.

CHENOPODIACEAE.

Chenopodium album, *L.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Taklakot, 13,000 ft., W. Tibet, July, 1926; Jiu, 15,000 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929.

Chenopodium Botrys, *L.*

Ladak, 1920.

Chenopodium Blitum, *L.*

Taklakot, 13,000 ft., W. Tibet, July, 1926; Jiu, 15,000 ft., W. Tibet, July, 1926.

Atriplex crassifolia, *C. A. Mey.*

Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926.

Eurotia ceratoides, *C. A. Mey.*

Ladak, 1920; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Barkha Plain, 15,000 ft., W. Tibet, July, 1926.

Axyris amaranthoides, *Linn.*

Below Phirtse la, 15,000 ft., Zanskar, Aug., 1928.

Chenolea divaricata, *H.f.*

Ladak, 1920.

Kochia prostrata, *Schrad.*

Ladak, 1920; Phirtse la, 15,000 ft., Zanskar, Aug., 1928.

Kochia odontoptera, *Schrenk.*

Ladak, 1920.

Salsola collina, *C. A. Mey.*
Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926.

POLYGONACEAE.

Polygonum islandicum, *Hk.f.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Polygonum cognatum, *Meissn.*
Taklakot, 13,000 ft., W. Tibet, July, 1926; Pala, 14,000 ft., W. Tibet, July, 1926; Camp to Losar, Spiti, 14,000 ft., 14th Aug., 1928.

Polygonum paronychioides, *C. A. Mey.*
Ladak, 1920.

Polygonum aviculare, *Linn.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Polygonum plebejum, *Br.*
Ladak, 1920; Camp to Camp in Spiti, 14,500 ft., Aug., 1928.

Polygonum viviparum, *Linn.*
Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Phari, 14,300 ft., C. Tibet, July, 1930; Khangma, 13,900 ft., C. Tibet, July, 1929.

Polygonum affine, *Don.*
Kinlung, 15,000 ft., Rupshu, July, 1919.

Polygonum rumicifolium, *Royle.*
Camp to Camp in Spiti, 15,000 ft., 13th Aug., 1928.

Polygonum tortuosum, *Don.*
Ladak, 1920; Rakastal, 15,000 ft., W. Tibet, July, 1926.

Polygonum sibiricum, *Laxm.*
Ladak, 1920; Lingti plains, 14,000 ft., Rupshu, Aug., 1928; Taklakot, 13,000 ft., W. Tibet, July, 1926; Jiu, 15,000 ft., W. Tibet, July, 1926; Phari, 14,300 ft., C. Tibet, July, 1930; Samada, 14,100 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, Aug., 1930.

Polygonum sp.
Kala, 14,600 ft., C. Tibet, July, 1929.

Fagopyrum emarginatum, *Meissn.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Taklakot, 13,000 ft., W. Tibet, July, 1926.

Rheum spiciforme, *Royle.*
Ladak, 1920; Rakastal, 15,000 ft., W. Tibet, July, 1926; Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926.

Oxyria digyna, *Hill.*
Ladak, 1920; Kinlung, 15,000 ft., Rupshu, July, 1919.

Rumex orientalis, *Bernh.*
Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926.

Rumax nepalensis, *Spreng.*
Khangma, 13,900 ft., C. Tibet, July, 1929.

Rumex acetosa, *Linn.*
Ladak, 1920.

THYMELAEACEAE.

Stellera Chamaejasme, *Linn.*
Dochen, 14,700 ft., C. Tibet, July, 1930; Khangma, 13,900 ft., C. Tibet, July, 1929.

ELAEAGNACEAE.

Hippophae rhamnoides, *Linn.*
Ladak, 1920; Rungung, 14,000 ft., W. Tibet, July, 1926.

EUPHORBIACEAE.

Euphorbia tibetica, *Boiss.*
Ladak, 1920; Taklakot, 13,000 ft., W. Tibet, July, 1926.

URTICACEAE.

Urtica hyperborea, *Jacq.*
Kinlung, 15,000 ft., Rupshu, July, 1919; Darchan, 15,000 ft., W. Tibet, July, 1926; Tuna, 14,700 ft., C. Tibet, July, 1930. Very common in Tibet.

SALICINEAE.

Salix hastata, *L.*
Saugong, 13,400 ft., C. Tibet, July, 1930.

Salix insignis, *Anderss.*
Taklakot, 13,000 ft., W. Tibet, July, 1926.

Salix calyculata, *H.f.*
Zanskar, Aug., 1928.

Salix sp.
Losar, 13,000 ft., Spiti, July, 1928.

Salix sp.
Spiti, 14,000 ft., Aug., 1928.

Salix sp.
Losar, 13,000 ft., Spiti, Aug., 1928.

Salix sp.
Taklakot, 13,000 ft., W. Tibet, July, 1926.

GNETACEAE.

Ephedra vulgaris, *Rich.*
Beyond Baralacha, about 15,000 ft., Rupshu, Aug., 1928; Camp in Spiti, 14,000 ft., Aug., 1928; Zanskar, 14,000 ft., Aug., 1928; Khangma, 13,900 ft., C. Tibet, July, 1929; Samada, 14,100 ft., C. Tibet, July, 1929.

Ephedra intermedia, *Schrenk.*
Ladak, 1920.

CONIFERAE.

Juniperus macropoda, *Boiss.*
Ladak, 1920.

ORCHIDEAE.

Orchis Chusua, *Don.*
Way to Gyantse, C. Tibet, July, 1929; Above Gyantse, C. Tibet, Aug., 1930.

IRIDEAE.

Iris ensata, *Thunb.*

Gyantse, 13,000 ft., C. Tibet, July, 1930.

LILIACEAE.

Allium Schoenoprasum, *L.*

Ladak, 1920.

Allium blandum, *Wall.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Allium Schrenki, *Regel.*

Gyantse Road, C. Tibet, July, 1930; Khangma, 13,900 ft., C. Tibet, July, 1929.

Allium odorum, *Linn.*

Camp to Gaurikund, 16,500–18,600 ft., Kailas Round, W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Allium tuberosum, *Roxb.*

Tirthapuri, 14,500 ft., W. Tibet, July, 1926.

Allium Govanianum, *W. A. Smith.*

Khangma, 13,900 ft., C. Tibet, July, 1929.

Fritillaria Gardneriana, *Wall.*

Phari, 14,300 ft., C. Tibet, July, 1930.

Lloydia serotina, *Reichb.*

Gaurikund, 18,500 ft., Kailas Round, W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930.

Tofieldia himalaica, *Baker.*

Gyantse Road, C. Tibet, July, 1930; Dochen, 14,700 ft., C. Tibet, July, 1930.

JUNCACEAE.

Juncus leucomelas, *Royle.*

Camp in Spiti, 14,000 ft., Aug., 1928.

Juncus allioides, *Franch.*

Gyantse Road, C. Tibet, July, 1930.

Juncus Thomsoni, *Buch.*

I to II Camp of Kailas Round, 16,500–18,600 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Rungung, 14,000 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930.

NAIADACEAE.

Triglochin palustre, *Linn.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Barkha Plain, 15,000 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1929.

Triglochin maritimum, *L.*

Kinlung, 15,000 ft., Rupshu, July, 1919; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Gyantse Road, C. Tibet, July, 1930.

Potamogeton perfoliatus, *L.*

Gyantse Road, C. Tibet, July, 1930.

Potamogeton pectinatus, *L.*

Manasarowar, 15,000 ft., W. Tibet, July, 1926; Darchan, 15,000 ft., W. Tibet, July, 1926; Tirthapuri, 14,500 ft., W. Tibet, July, 1926; Dulchu to Tirthapuri, 15,000–14,500 ft., W. Tibet, July, 1926; Kala, 14,600 ft., C. Tibet, July, 1929; Gyantse Road, C. Tibet, Aug., 1930.

Section of Agriculture.

President:—G. N. Rangaswami Ayyangar, B.A., I.A.S.

Presidential Address.

The Inheritance of Characters in Ragi, *Eleusine coracana* (Gaertn).

Introduction.

Agriculture is predominantly a problem of Crop Industry. Crops have in recent years begun to be studied with increasing intensity. Specialisation in them is the order of the day, though it has been recognised by the highest authorities that a wider outlook is imparted by not confining the specialisation to a single crop. Being familiar with Rice, I find millets, the group of cereals which I am studying at present, affording a convenient opportunity for a comparative study of cereal genetics and the bearing of this study on the subject of Crop Genetics in general. I am, therefore, proposing to address you on the results of seven years of work on one of the millets, viz., Ragi, *Eleusine coracana* Gaertn, named after Eleusine, the Greek Goddess of Cereals. In choosing this millet, I have the feeling of appropriateness of dealing here, at Bangalore, with the premier cereal of the Mysore State. From the general Indian point of view, the reputation of this cereal for its keeping qualities gives it a prominent place as a famine reserve. I intend to use the studies on this crop as a thread with which to string some of my general observations on genetics in relation to the improvement of cereals.

The Plant.

Eleusine coracana, Gaertn, Ragi—is a small grained cereal belonging to the group of cultivated plants called Millets. A medium-sized annual, it grows to a height of 3 to 4 feet and has a capacity to tiller and branch freely. An individual plant resembles a chandelier more or less in general outline and configuration. The stem is somewhat compressed, elliptic, tough and smooth and much ensheathed, exposing very little of the internodes. The leaf blade has a prominent midrib, and in spite of this many of the fully grown leaves show a tendency to snap and hang down about their upper middle. The inflorescence which is characteristic of this cereal is borne on a long peduncle, from the end of which 4 to 6 spikes radiate in a whorl. The spikes are called fingers, and the odd one a little lower down often found

attached to one edge of the flattened peduncle, is called the thumb. The spikes are either straight or curved inwards. In each finger there are a number of spikelets (60 to 80) which are arranged in two rows and alternately attached to one side of a flattened rachis. The spikelets are sessile and contain 5 to 8 glumes each, of which the two lowermost are barren and the rest are paleate enclosing a complete flower, consisting of an ovary with two feathery stigmas and three anthers, set between two lodicules. The anther lobes longitudinally dehisce and with their inverted margins present the appearance of two boats back to back. The ovule develops into a seed which is globular and encased in a membranous pericarp.

Flowering.

The inflorescence of Ragi consists, as already described, of a terminal whorl of 4 to 6 spikes. In each finger there are about 70 spikelets, each spikelet having 5 to 7 complete flowers. In the spikelet the flowering proceeds from bottom to top and in a finger the order of flowering is from the top spikelet downward. An earhead contains 1,500 to 3,000 flowers and the flowering period varies from 8 to 10 days, the largest number opening on the third day. The flowering takes place actively past midnight, from 1 to 5 a.m. Varieties with open earheads start flowering between 1 and 2 a.m., and those with curved earheads between 2 and 3 a.m. *E. aegyptiaca*, a wild ally of Ragi, flowers between midnight and 2 a.m. It is interesting to observe the close similarity in the time of anthesis of the open Ragis and *E. aegyptiaca*, indicating a sliding down of the period of anthesis towards the earlier hours of the morning in the case of the more compact and incurved varieties. As soon as the glume and palea begin to gape, the stigma and anther emerge almost concurrently and soon after, the anthers dehisce and pollinate their own stigmas. Self-pollination is thus assured, though occasional cross-pollination in nature by wind and insects is not excluded. The glumes close between 7 and 8 a.m.

Anthesis Studies in General.

Anthesis studies are a necessary preliminary to studies on heredity in plants. The mechanism of pollination is of very great importance as its study throws considerable light on fertility and problems connected with it. This delicate process of pollination is very susceptible to modification within limits. In *Pennisetum typhoideum* flowering has been noticed to proceed throughout the day and night with the main concentration at about 9 p.m., a secondary spurt at about 9 a.m., and a definite dullening round about 3 p.m. The protogynous nature of this millet, the pencillate anthers

and the absence of lodicules partly explain this peculiar floral conduct. But the fact that certain of its wild allies like *P. cenchroides*, the flowers of which open from 2 to 11 a.m., of *P. ruppelli* from 10 p.m. to 11 a.m., and of *P. purpureum* from 7 a.m. to 12 noon, raises the possibility of this all day flowering being a concomitant of the packed cultivated condition of the earhead of *P. typhoideum*. In *Setaria italica* the march of flowering keeps pace directly with increase in humidity and inversely with increase in temperature. In Sorghum the maximum of flowering occurs at 2 a.m. There is thus a tendency for these cereals of the dry tracts to flower during the night. An analysis of the rain hours in rainy days as far as available, communicated by the Meteorological Department, shows the chief maximum amount of rainfall just after midnight. It is a tragic situation in which some of these millets in their successful attempts to escape flowering in the day's heat run into disabilities consequent on midnight rain. Their only chance of successful pollination lies in the absence of night rain at optimum flowering time. These observations are made in detail to give an idea of the vicissitudes which the efforts of a breeder of Millets pass through. Apart from the isolated instance of Goldschmidt, no systematic attempts have been made to analyse the factors responsible for the opening of flowers. It is high time research work is directed to determine the various factors contributing to the opening of flowers and find out how far a survey of such floral habits could afford opportunities for the perpetuation of favourable variants.

Artificial Crossing.

Millets are small grains in general and the flowers of Eleusine are very tiny. The want of individuality to each floral unit and the serried and closely overlapping arrangement of the spikelets make it difficult to pollinate the flowers artificially and is a great handicap for the study of its heredity. In the earlier years of my work, before the inheritance of certain obvious characters involving purple pigmentation was known, much time, trouble and patience were expended in evolving a technique of artificial pollination with only very limited results. The delicacy of manipulation required and the quickness of the anthesis militate against success. But with the increase in our knowledge of the dominance of certain well marked characters it has been possible to clip off all except a single finger or part thereof, in certain varieties and pollinate the flowers by contact with the desired earhead, taking the usual precautions for keeping off undesired pollen. Seeds from the mother finger are then sown with the certainty of spotting the first generation hybrids even in the

seedling stage. Using the method described above a number of hybrids have been raised successfully at the Millet Breeding Station, Coimbatore. This short cut while it lacks the element of romance which usually kindles the admiration of the layman regarding the mysteries of the breeder's art, nevertheless, provides, at an advanced stage of the breeder's experience, a ready weapon for a quick pursuit of the inheritance of many characters. Much experience is necessary in designing such crosses and a note of caution is here sounded against the use of this method by inexperienced persons.

Purple Pigment in Crops.

Without the existence of colour other than green, nature would be one vast monotonous expanse of emerald. The only diversity would then be that introduced by variation in form. The revelry of colour in nature and an accentuation of it in her reproductive phase, leave no doubt as to its vital functions. Vegetative adaptations of a colour type must have a physiological bearing and be intimately linked to vital metabolic processes. When crops are grown and compulsory monotony introduced the function of colour is baffling. If selective influences had voted in favour of colour, as reasonably they might, then crops would have been one mass of purple. The fact that both pigmented and unpigmented varieties figure prominently as types of cultivated plants, surviving and perpetuated as economic varieties, is proof positive of the fact that colour as seen is not the only determinant in the survival of a crop variety. The absence of colour has not meant the dethroning of unpigmented varieties. It is therefore arguable that colour as seen and colour potentiality should both be the determining factors in the success of a cultivated variety. To a plant breeder this question of colour evokes the first curiosity necessary for a later sober pursuit of other less striking manifestations of heredity in crops.

Purple Pigment in Ragi.

In Ragi, as in most other cereals, there are many colour types and one broad group characterised by the absence of colour. Each colour group is a variant from the one of a lower degree with a single factor difference. The manifestation of colour varies both in intensity and in distribution, different factors being involved in the process. Genetically basic colour is produced by a factor P and its effect is accentuated in depth and distribution by two intensification factors I_1 and I_2. There is the broad separation between colour seen and colour potential. The Green-throughouts, though they look alike, are separate genetic entities with different potentialities for developing colour, which can only be determined

by breeding tests. They require the introduction of the purple factor to unfold their potentialities to their full expression. They are like undeveloped but exposed photographic plates, all alike, only waiting to show their individuality in the presence of the universal developer anthocyan. What it is that determines where colour shall be manifested and in what depth, is a large basic problem in bio-chemistry and plant-physiology, that has so far not had a generally acceptable solution. To me therefore it appears that the time is ripe to proceed beyond the well known purple dominance and probe into the basic problem of the very production and distribution of purple pigmentation in the crop world.

Earhead Shapes.

Next to colour the earhead shapes provide a marked character for sub-grouping the varieties of Ragi. There are two broad groups—those in which the digitate spikes of the inflorescence curve in and those in which they are open.

A factor for Density designated Q, manifesting itself in a close packing of spikelets on the rachis is present in the Curveds and absent in the Opens.

The Curveds are separable into In-curveds and Top-curveds. In the In-curveds the spikes curve in. The Top-curveds are longer than the In-curveds and in them, only the tops of the spikes curve. A second factor E is concerned with the elongation of the rachis and separates the Top-curveds from the In-curveds. The effects of the E factor begin to show out in the plant even before the emergence of the earhead. Its presence is revealed by the elongation of the flag, the greater length of the peduncle and the increased height of the plant. The E factor is present in the Opens also so that two groups of them, the Long-opens and Short-opens can be distinguished. Their separation is difficult, but their existence and individuality could easily be demonstrated from segregates of crosses with Top-curveds and In-curveds respectively.

The length of the fingers in Short-opens and Long-opens generally ranges in the former from 7 to 12 cm. and in the latter from 10 to 19 cm. They thus overlap slightly. To prove the genetic individuality of the two groups, selections were made from the overlapping zones of finger length and breeding tests carried out. The progeny were found to be true to their parental ranges irrespective of the lengths of the parents chosen.

Quality Soul of Quantity.

Earhead shape is a form-complex with its length, breadth and thickness and within certain limits liable to variation

through environment. In dealing with the heredity of this form-complex, we run into a realm where measurements are possible and where the results of such measurements cannot be read aright without the perception that behind this arithmetic there are distinctive qualities of a genetic type, which the accuracy of measurement merely clothes in the latest style. In biology behind every quantitative manner of presentation is a quality, a character, not easily spotted but delimitable through measurements. A mass of mathematical data has often connoted very little for the simple reason that it lacked the soul of quality. A series of measurements of earhead lengths in a variety of Open Ragi gives a curve the constituent parts of which do not become evident without the help of breeding with sister families in which, measurements apart, distinct qualitative sub-groups could be located. I take this opportunity of observing that in the application of mere formulas accounting for the significance or otherwise of statistical data in crop biology, there should be no forgetting, that we are dealing with life drilled and mobilised by man and that the opportunity which the crop breeder has of multiplying his seed material in numbers and through generations, gives him a far surer and more tangible natural standard by which to measure the significance of his experiments.

Grain Colour.

From the earhead we pass on to the grain. Unlike other cereals there is not much wealth of grain colour in Ragi. It is one dull drab. The Ragi grain has a characteristic brown colour, which I have designated Ragi Brown. The pigment is confined to the outer layer of the seed coat. This Ragi Brown is produced by two factors B_1 and B_2 either alone or together. This brown colour of the grain is in intimate genetic relationship with Purple Pigmentation on the Plant. This Purple Pigmentation is produced by a factor S working in association with either or both of the B factors. This accounts for the absence of white grained Ragi in purple pigmented plants. Some races of white grains carry the factor S. Crosses have been made between white grained plants containing the S factor, and brown grained Greenthroughouts, and the resulting F_1 plants were purple pigmented and brown grained. These crosses behaved as expected in later generations.

Plant and Grain Pigments.

Man has a natural predilection to produce a white grain in all his cereals. In Ragi, however, the predominant colour continues to be brown. People using this grain get reconciled to the brown tint of the cooked gruel. The more agreeable

white Ragi is comparatively less vigorous and poor yielding and is consequently rare in cultivation. Nevertheless it required a white grained Ragi with the S factor, to figure in a cross and resolve both the Plant Purple and the Grain Brown of the Ragi into their genetic components. This fact is of considerable significance in the evolution and survival value of the existing cultivated varieties of Ragi. This phenomenon opens up a piquant problem in the bio-chemistry of plant pigments.

Depth of Brown.

Certain races are met with in which the Ragi colour of the grain is of a darker shade. Given fair weather and normal ripening, the separation between the ordinary Ragi Brown and the Dark Ragi Brown is well marked. Over-ripening or a downpour of rain at ripening period tends to make the normal colour dark, and the dark colour reddish black, with the result that the separation of the two becomes rather difficult. These difficulties notwithstanding, the dark Ragi Brown has been found to be produced by a definite factor D which, acting on the Ragi Brown, makes it Dark Brown. This factor behaves as a simple dominant, and is independent of the factors concerned in the production of Plant Purple Pigmentation and is not in selective association with either of the B factors.

Pericarp Green.

Young developing grains of Ragi have generally a green pericarp. This green colour shows itself while the grain is still young and enclosed within the glumes, and through the transparent tissues between the glumal veins it gives the earhead the characteristic green look in the early stages of flowering. The pericarp continues to be green even after the growing grain passes the milky stage, but about a week after, it dries off into a thin, loose, greyish translucent and fairly persistent membrane enclosing the mature grain. A variant of this type has been met with. This has a distinct light green pericarp, which in the early stages gives a lighter tint of green even to the earhead. The green pericarp is brought about by the presence of a factor designated C_x which is a simple dominant to the light green pericarp. This factor C_x is independent of the factors for Plant Purple Pigmentation and Grain Colours.

Anther and Pericarp Relations.

The green pericarp is associated with a dry anther mass of Pale Orange Yellow and the light green pericarp, with Ivory Yellow. This association between anther colour and the colour of the pericarp is noticeable in other naked grains.

In Sorghum for example, there is a very close relation between the colour of the anther, fresh and dry, and the colour of the grain. These affinities throw considerable light on the structural and other relationships existing between parts of plants and open up a wide and fruitful line of investigation.

Chlorophyll Deficiency.

This factor for depth of green leads to an examination of the factors responsible for the production of chlorophyll. In the commonly cultivated varieties lethal conditions would have had a natural elimination. But in a breeding station, where seeds of different varieties from different parts of the country are collected and grown side by side they have a chance of free mating with each other, from which some defective forms will be produced, of which albinism is one. All workers on crops have experienced some aspect or other of this albino condition. Albinism is the total absence of chlorophyll. Partial absence is also met with. In some cases this causes death, while in others it acts as a drag on life without extinguishing it. Even in healthy crops gradations in the depth of green are met with. An analysis of the factors responsible for the production of chlorophyll reveal the presence of a number of factors in maize, the crop in which this aspect has been worked out in great detail Albinism has also been found in *Setaria italica*, *Pennisetum typhoideum*, and in *Paspalum scrobiculatum*. In Sorghum five types of chlorophyll deficiency have been met with. In Ragi two factors designated C_1 and C_2 either alone or conjointly seem to be responsible for the production of chlorophyll, so far as our present knowledge of it goes. It has been found to be possible to isolate the two factors and produce albinos at will by crossing them.

Chlorophyll Efficiency.

This raises the general question of chlorophyll deficiency, as it is graphically seen in the albino, serving to give a clue to the all-vital question of chlorophyll efficiency. Under non-lethal conditions a placid contentment dismisses higher possibilities of building up this efficiency. It is a matter for examination whether the vigour usually associated with hybrids may not be a form of this efficiency. It is common experience that crops vary in the depth of green which they present *en masse*. This is undoubtedly a varietal character. It has recently been demonstrated in Sorghum that there is a linkage between the factors for Purple Pigmentation and Albinism. This again raises the ring of affinities that should exist in the purple pigmented variety of a crop, its simple green form and the gradation of paler forms down to bleached seedlings

emerging to die. The whole scheme opens itself to a systematic examination and awaits the expert handling of a master Bio-chemist.

Sterility.

Chronic sterility, short of complete sterility, is occasionally met with in Ragi. It manifests itself in an almost complete failure to set seed and gives the earheads a blighted look. Sterile plants grow vigorously, flower late and put forth numerous heads. The anthers lack the free and quick protrusion which gives the healthy earheads that fullness characteristic of the blooming period. The stigmas are healthy and receptive.

The cause of this sterility is two-fold, (1) Non-dehiscence of anthers, and (2) Agglutination of pollen. In the first type of sterility the anthers are of the same shape and size as healthy ones. They are full of viable pollen grains, but the anther sacs do not dehisce and liberate their contents. In the second type of sterility a disintegrated mass of agglutinated pollen devoid of contents is produced. In both the types, however, a few stray grains develop and help to keep the race going. Normal dehiscence occurs with the presence of factor X. Free pollen is produced by factor Y. Both the factors X and Y behave as simple dominants to their absence which results in sterility. The X and Y factors are independent of the factors responsible for Plant Purple Pigmentation.

Fertility.

This experience is very interesting in that definite genetic factors have been traced to account for so vital a condition as sterility. As in the case of albinism this raises possibilities of attacking and resolving the elusive problem of yield into its component parts traceable to genetic factors and thus help to grade up fertility.

Chromosomes.

Subba Rao has recorded 18 pairs of chromosomes in Ragi. Thirteen independent factors, namely B_1, B_2, C_1, C_2, C_x, D, E, I_1, I_2, Q, S, X, and Y, have so far been accounted for. The rest have to be worked out and located. It is remarkable that so far no linkages have been met with.

In all crop studies it is very necessary to aim at having a chromosomal chart of the crop to enable characters to be pursued with clarity and crosses designed with effect. In this direction lies a vast field for young botanists in the coming years.

Seasonal Adaptability.

Concurrently with the study of this equipment of the characters of the individual Ragi plant, a study has been started of the crop as a community. Ragi has the reputation of being a cosmopolitan cereal. Its capacity to adapt itself to various types of soil is well known. Experiments designed to throw light on its adaptability to sowings at different seasons within a year reveal the fact that this cereal has a second favourable season for its growth in addition to the usual main season. The vicissitudes in yield are less sharply marked in a year, than is the case with Rice, which Ragi replaces under conditions of scarcity of water. With a longer duration variety the response to favourable or unfavourable circumstances is more marked than with a short duration variety. In the case of the longer duration variety its adaptability to the second summer season is more pronounced than is the case with a short one. Yield generally increasing with duration, these experiments indicate the necessity of evolving a strain with a medium duration that would ensure a fairly steady yield through the years and yet stand a certain amount of unfavourable circumstances or neglect within a year.

Mixture of Strains.

The intense crop breeding activities of the past quarter of a century give rise to certain reflections of fundamental importance. To a breeder of millets accustomed to an erratic monsoon the question arises whether it is not time to deviate from the orthodox conception of a pure strain and adapt his methods to the more practical end of creating a mixed population of good strains so that their varying adaptabilities may ensure an evenness of performance through years An agricultural variety has the common characteristic of a fair amount of evenness in size of grain, height of plant and duration of life. Other minor morphological differences are of little consequence. From the composition of many of the existing varieties that have successfully survived the rigorous demands of time, it strikes me whether an abstract search after genetic purity should not give place, in the breeding of millets, to the unorthodox method of creating a population with possibilities of crossing with each other in non-essential characters and thus increasing their hybrid vigour with no serious detriment to the fundamental attributes that characterise a variety. It is a proposition worth considering whether the breeder's art may not be utilised to spot and weed out the unfit individuals and leave the crop community with the *elite* of the population. The matter is otherwise with more favourably placed crops.

Time–the Arbiter.

The existing varieties of cultivated plants have been evolved through and are the product of centuries of selective influences adding to their survival value. Selection is no simple process. To a rare few it is an intuitive gift. To the many, it is a perennial game of hide and seek, played with nature. Intensive studies in pure lines of any crop may give a number of interesting co-relations. Yield is such an elusive factor that it is very difficult to make it easily fall in line with these co-relations. There are certain conditions in the life of a crop when it becomes more or less static. Selection then is of no avail. Hybridisation begins where selection is bankrupt. Wise and judicious selection again follows hybridisation. To one in the business, hybridisation is a simple process made easy with practice. This convenient tool and the easy qualitative deductions in simple Mendelian ratios that have characterised the mass of output of genetic literature in recent years, coupled with the linking up of such experiments to economic departments like Agriculture with their demands for improved strains, creates a situation that leads to the quick output of new strains not tested by time. There is posterity and the time spirit to judge the soundness of an effort. Premature usherings of 'Improved' varieties may be spectacular, but sooner or later these will find their level Time is the sure arbiter. It is true that all effort is limited to the span of one's opportunity and active service. The time factor ought not to deter effort, but rather should it tune up the sense of the ideal in the plant breeder that will develop in him the coolness and the vision which enables him to build and build soundly on sure foundations, with a fervour that checks every gamble with an opportunity. It is obvious therefore that apart from the initial verdict occasionally elating and often depressing, there is sure to be the saner verdict of time, over an effort soundly designed and sincerely executed

Section of Agriculture.

Abstracts.

SOIL SCIENCE.

1. The study of the lateral movement of salts in soils.

V. A. TAMHANE *and* J. J. CHANDANANI, Sakrand, Sind.

Owing to the advent of perennial irrigation in Sind, a number of problems affecting the soil conditions are likely to occur. One of these problems is the lateral movement of moisture in the soil along the canals and the water courses and the subsequent appearance of soluble salts on the surface of the soil rendering fertile soils barren owing to high concentration of such salts. There is no known method of determining if the salts actually move laterally from bad land to good land or are only brought up from the lower layers to the surface by force of capillarity. The present paper conclusively proves that the soluble salts do move laterally. The *modus operandi* is as follows :—

A small pit is dug in the centre of a field; its bottom is made watertight by cementing the floor. The pit is kept filled with a dilute solution of potassium chromate and the distance travelled by the yellow salt noted from time to time and confirmed by laboratory tests of the soil extract and the rate of migration determined.

2. A new method for the determination of sodium in saline soils.

V. A. TAMHANE *and* M. A. SHAMA IYENGAR, Sakrand, Sind.

A new short method is proposed for the determination of the injurious sodium in saline soils. The acidified soil water (1 : 5) extract is treated with ammonium chloride and boiling barium chloride and then an excess of ammonium carbonate and filtered. The sulphates and the excess of barium are thus removed, as also lime. The filtrate is then evaporated to dryness, ignited to dull red, cooled, extracted with water and titrated against standard silver nitrate and the sodium equivalent of chlorine calculated.

The method includes all the sodium and the potassium also in it. The possibility of their separation by weighing the mixed chlorides (KCl and $NaCl$) and titrating the common ion chlorine is being tested, in which case it will serve as an easy and direct method for sodium in soils.

3. Electrodialysis as a simple means of measuring the exchangeable bases in saline and calcareous soils.

J. K. BASU, Pusa.

The presence of Calcium Carbonate in soils has always presented an almost insurmountable difficulty in the determination of exchangeable bases, specially in soils containing soluble alkali bases. In the method proposed, this difficulty has been obviated to a considerable degree. An absolute value for the exchangeable bases is, however, obtainable in non-calcareous soils.

4. A study of profile development in alkali soils with a view to reclamation.

J. K. BASU *and* B. M. AMIN, Pusa.

Preliminary investigations into the Kalar (Saline) soils of Sind have emphasised the importance of a thorough study of the soil profile, its origin, development and the movement of the soil bases as affecting the formation and the reclamation of saline soils.

These investigations have shown that the soil medium is alkaline and that the distribution of ions favours the ultimate formation of a solonetz soil.

Study of the exchangeable bases has thrown light on the degree of alkalisation in the soils and the ultimate danger in permitting the continuation of this process under post-Barrage conditions. Laboratory trials have so far yielded very valuable results with respect to reclamation.

5. Further observations on the soil conditions as affecting the growth of sugarcane in the district of Saran in North Bihar.

M. N. GHOSH *and* H. N. MUKHERJI, Sabour.

Further observations showed that in a year, like the present, of excessive rain in July which would wash away the soil salts beyond the reach of sugarcane roots, the general unhealthiness of the crop might arise not from an excess of salts but from a shortage of available nutrients in the soil. Canes deeply planted from setts obtained from the most vigorous plants of the past year had abundant deep-going root-systems and were healthy throughout. The unhealthy canes had root-systems confined within a smaller soil area and were unable to produce fresh roots when the soil conditions changed according to the changes of weather from dryness to wetness and again to dryness. Attack by root-borers and fungii also increased the unhealthiness of the crop. The sick canes contained less mineral matters than the healthy canes, but they consisted more of alkali salts than lime and magnesia. Remedies proposed are rigorous selection of setts for seed, adequate supply of organic matter before planting and of soluble nutrients in July and improvement in the methods of cultivation and earthing up.

6. A note on the 'Observations on the acidity of Laterite soils of the Bombay Presidency'.

V. V. GADGIL, R. M. HEGDEKATTI, *and* M. R. GOKARN, Ratnagiri.

Laterite soils of South Konkan are poor in lime, phosphoric acid and nitrogen as compared with the soils derived from the trap rock of North Konkan.

The application of organic manure as F.Y.M., green leaves, dry leaves, etc., gives decided advantage on the growth of crops, specially rice and cannot be dispensed with.

These soils are acidic in reaction which is corrected by the application of lime and the results in yields run high when plant nutrients are supplied in more easily available combinations.

Bone meal, though mainly used as a Phosphoric manure has direct effect on the acid reaction of the soil and thus has greater effect upon the grain formation than the other soluble phosphates which counteract the effect of phosphoric acid by increasing acidity.

The application of bone meal gives higher outturn when applied in the presence of heavy doses of easily fermentable green leaves of the forest vegetation; thus the problem of the increase in yield of most of the crops grown on Laterite soils depends on the alkaline reaction of manures which should have greater scope.

The correction of soil acidity by these methods of applying manures, requires more thorough investigation.

7. Some aspects of the growth of rice in heavy black soils of the Central Provinces.

D. V. BAL *and* R. N. MISRA, Nagpur.

Some aspects of the growth of rice in heavy soils have been studied.

Results of the mechanical analyses of the light and heavy rice soils of the Central Provinces show that the former possess a lower pH value than the latter.

When a heavy soil formerly under wheat is converted into a rice field, the percentage of lime in the soil is decreased and there is also a corresponding reduction in the pH value of the soil.

Experiments on the growth of rice in sand cultures with nutrient solutions of different pH values indicate that the rice plant prefers a slightly acidic or neutral medium to an alkaline one.

It is seen from the pot and field experiments that the pH value of the soil is lowered by an adequate application of sulphur.

The results obtained from the pot and field experiments on rice indicate that in the case of heavy soils, with a basal dressing of green manure, sulphur gives increased outturn, but an annual application of super either individually or in combination with sulphur gives decidedly better results.

ELECTRICITY IN AGRICULTURE.

8. The response of the strawberry plant to electro-cultural treatment.

S. S. NEHRU, Naini Tal.

Strawberry plants have been treated to high tension spark and improvement in growth and fruit recorded. Further plants have been transferred to a radio-magnetic cradle and noticeable improvement in growth, tillering, fruit and resistance to virus disease registered. Twenty branches with ripening berries caught in a loop or collar of soft-iron magnet have yielded earlier, better, bigger and brighter fruit than the remaining branches of the same plant.

9. The response of flower plants to radiomagnetic treatment.

S. S. NEHRU, Naini Tal.

Twenty kinds of flower seeds (Antirrhinum mixed, Antirrhinum Black Prince, Acroclinum Rose, Alyssum Benthamii, Anchusa Capensis, Cosmos white, Cosmos pink, Candytuft, Empress white, Cornflower blue, Candytuft white, Coreopsis Beauty, Coreopsis brown and yellow, Dianthus crimson, Dianthus vesuvius, Eschsoltzia, Marigold, Nasturtium, Beauty of Waltham, Petunia new mixed, Phlox white, Sweet Sultan white) were sown under identical conditions in two adjoining beds, one radiomagnetic and the other control. Germination and growth was forced up to 30 per cent. in the former. Finally, the flowers were better, brighter and more profuse.

10. The response of Cotton and Barley to x-ray, violet-ray, ultra-violet-ray and radiomagnetic treatment.

S. S. NEHRU, Naini Tal.

The comparative merits of the three kinds of treatment on the germination, growth, and maturity of Cotton and Barley seed are given. Generally, x-rayed have done best, but ultra-violet-rays have reduced the period of germination from 7 to 4 days.

11. The response of miscellaneous hill crops to different kinds of Electrocultural treatment.

S. S. NEHRU, Naini Tal.

The seed of miscellaneous crops grown in hills [(Lobhia pulse, (a kind of string-bean), Gahat pulse (Dolicos biflorus), Til (Sesamum), three kinds, black, white and brown, Kauni millet (Setaria italica), Bhatt pulse (Soybean), Mandwa millet (Eleusine Coracana), Mung pulse, Paddy (rice)] and peas have been subjected to violet-ray high-tension spark, x-ray, ultra-violet-ray and radiomagnetic treatment and comparative results as to germination, growth, maturity, yield, etc., are given. Generally, x-ray and radiomagnetic cradle are the best.

12. The response of Tomato Leaf Curl to electrocultural treatment.

S. S. NEHRU, Naini Tal.

Previous tests have shown that leaf curl in chillies can be cured by the high tension spark and tickling treatment It has also been established that atmospheric electricity captured and conducted by means of a wireless aerial has effected a cure in the case of cyperus plant. In the present tests the above two methods were combined. Tomato plant suffering from leaf curl was set up on an insulated stand and connected with an L-shaped aerial pointing E. and W. and N. and S. The results after three months have been that a new crop of straight leaves have come out and it is expected that leaf curl has been suppressed if not eradicated.

13. The comparative merits of x-ray, violet-ray, ultra-violet-ray, high tension spark and radiomagnetic cradle for the purpose of electrocultural treatment.

S. S. NEHRU, Naini Tal.

A comparative picture of results of the response to x-ray, violet-ray, ultra-violet-ray, high tension spark, radiomagnetic cradle of a very wide variety of plants, from the standpoint of (1) Unseasonal character of sowing, (2) Germination, (3) Maturity, (4) Flowering, (5) Yield, and (6) Simplicity and cost of treatment will be presented and the question which method suits with which type of plant examined.

FERTILISERS.

14. Effect of the contact of chemical fertilisers with seeds on their germination.

V. G. GOKHALE *and* P. M. GAYWALA, Poona.

The authors describe the experiment that they carried out on this subject during the year 1930-31 at the Agricultural College, Poona, with

the fertiliser *Sulphate of Ammonia at the rate of 100 lbs. per acre* and with seeds of *Bajri, cotton* and *Shalu-Jowar*. Varying degrees of contact were obtained by applying the fertiliser in more or less nearness to the seeds as secured by dibbling and drilling the fertiliser and the seed, together or separately. Varying periods of contact of both, under dry conditions and those favourable for germination were also tested.

The main conclusions are :—

(1) 80 to 100 per cent. of seeds failed to germinate when the mixture of seeds and the fertiliser is dibbled in pinches, i.e., when the contact was direct and concentrated. Cotton seed has suffered the most.

(2) Drilling of the above mixture effects a marked improvement in germination which seems to be due to the partial lessening of contact and concentration owing probably to intervention of soil between the seed and the fertiliser.

(3) In all other treatments which secure complete break of the contact, germination is not affected.

(4) Keeping the seeds and the fertiliser mixed together in *dry* conditions up to two days does not injure the germination appreciably.

(5) The failure to germination occurs only when the fertiliser comes in close and direct contact under *soil-conditions favourable for germination.*

15. Further experiments in the use of sinews as manure for rice.

MOSES EZEKIEL, Bombay.

A paper on ' Sinews as a manure for rice ' was read at the Calcutta session of the Indian Science Congress in 1928. This paper further confirms the results then obtained. The tentative conclusions then drawn are now confirmed.

' Sinews ' can take the place of ' Rab ' in rice seed-beds.

They can be used as a general manure for rice in plots where the rice is transplanted.

' Sinews ' decompose quickly and give a vigorous start to the ' Seed-bed seedlings ' and also to the transplanted seedlings.

According to the analysis of the Agricultural Chemist to the Government of Bombay, ' Sinews ' contain 12·4 per cent. of nitrogen. A manure so easily decomposed and so rich in nitrogen may safely be tried for richer crops such as wheat, sugarcane or vegetables with good results, more so with vegetables with a leafy crop.

Perhaps a combination of Bone-dust and ' Sinews ' will give still more encouraging results in the outturn of grain, in all cereal crops.

BIO-CHEMISTRY.

16. Bio-chemical decomposition of plant residues in the presence of certain elements.

J. JAGANNATHA RAO *and* V. SUBRAHMANYAN, Bangalore.

Ragi straw was decomposed, in the presence of minute quantities of elements like Uranium, Titanium and Copper. Even in the early days of decomposition there was strikingly a great number of actinomyces colonies in the one treated with copper, fungi being few in number. Also the loss of organic matter was the same in the control and in the copper treated ones. This suggests that actinomyces play a great part in the decomposition of cellulosic material.

The bottles were exposed to direct sun light at intervals, for 24 hours, and there was no increased ammonification or nitrification in the bottles containing photosensitizers like Titanium or Zinc—indicating the insignificant part played by these elements in those processes in decomposing manures or soils.

17. Cold storage of mangoes.

D. V. KARMARKAR *and* B. N. BANERJEE, Bangalore.

Last year's experiments on preservation at low temperature have been continued this season, at controlled temperature of 37°C., 27°C., 10°C., 5°C., and 0°C. Lower temperature retards the respiration rate, but humidity and ventilation are serious factors for spoilage. In the last experiments, humidity and ventilation were not under control. Smearing the surface with oil or confining in an atmosphere rich in CO_2 also retard the respiration rate. Cold helps preservation but at 0° all cell activity stops, and mature mangoes kept at 0° do not ripen afterwards. Ripe mangoes frozen hard in liquid CO_2 and kept at 0°, suffer for edible purposes from diffusion and evaporation. A ripe mango should either be kept frozen, or a mature mango allowed to ripen very slowly at a temperature of 5 to 10°C. under controlled humidity and ventilation.

CROPS.

18. Inhibitory factor hypothesis and inheritance of quantitative characters in rice (*O. sativa*).

K. RAMIAH, Coimbatore.

Previous work on two sets of crosses involving three pure lines, A×B and B×C, had shown that plant height and flowering duration were positively correlated to a very high degree, the short and early being a simple dominant over tall and late in one cross and a simple recessive in the other. The four types, short early dominant, short early recessive, tall late dominant, and tall late recessive were extracted from these crosses and all the six possible crosses among these four types were then made, and the paper deals with the results obtained in the F_1, F_2 and F_3 generations of these six crosses.

The F_2 results are all explainable either on a three-factor hypothesis, or on a two-factor one, of which one acts as an inhibitor of the other. Although the inhibitory factor hypothesis has been used for explaining 13 : 3 ratios of certain qualitative characters in the F_2, the three-factor hypothesis expounded in this paper appears to be less complicated and more suitable for the inheritance of such quantitative characters as height of plant and flowering duration.

19. Some observations on the inheritance in rice.

S. K. MITRA *and* P. M. GANGULI, Jorhat, Assam.

The paper gives a brief statement about the results of a number of crosses made on rice at the Government Rice Farm at Karimganj, Sylhet, in regard to various characters such as awn, outerglume (length), size and shape of grains, glutinous endosperm, panicle, clustering of spikelets, double kernel, straw, and flowering (early *vs.* late). The goodness of fit was calculated in each case.

20. The relative growth rate of the rice plant under different treatments.

R. H. DASTUR, Bombay.

This work was undertaken to study the relative growth rate of the rice plant. The relative growth rate was measured according to the formula

$$RGR = \mathrm{Log}_e W_1 - \mathrm{Log}_e W_0,$$

where W_0 and W_1 are the dry weights of the plant at the beginning and at the end of a period of time selected.

Similarly the relative growth rates of the leaves and of the culms and roots were also determined separately.

The leaf area ratio, *i.e.*, the leaf area per unit dry wt. was also determined.

It is noticed that the relative growth rate reached its maximum by the middle of August. The same was true of the relative growth rates of the leaves and culms and roots.

It is established by Mr. Malkani in the laboratory by analysing the culture solutions of at least 300 experiments that the absorption of NH_4 ions decreases as the rice plant ages and the absorption of NO_3 ions increases as the age advances. The absorption of these two ions is independent of the absence or presence of other ions. These results and the results of the absorption ratios for these two ions suggest that a mixture of $(NH_4)_2SO_4$ and KNO_3 would be a better source of nitrogen than any one of them used singly or on an equal nitrogen basis. So the relative growth rates of the rice plants manured with (1) KNO_3, (2) $(NH_4)_2SO_4$ and (3) $\frac{1}{2}KNO_3+\frac{1}{2}(NH_4)_2SO_4$ are studied.

Similarly the relative growth rates of the rice plant manured in the three different ways on the 1st August, 1st September, 15th September and 1st October are also determined with a view to determine the best time for manuring. The results show (1) That the rice plants manured with the mixture of $(NH_4)_2SO_4$ and KNO_3 attain the highest maximum relative growth rates as compared with the plants manured with any of them singly. (2) The highest relative growth rates of the rice plants are obtained in the middle of August in all cases of manuring.

It was pointed out that the highest growth of the rice plant when manured with the mixture of $(NH_4)_2SO_4$ and KNO_3 might be due to the lack of potash in the soil and as the mixture contains K in addition to Nitrogen the most vigorous growth takes place in those plants. But the subsequent experiments in which KNO_3 was replaced by Soda nitrate again confirmed the above results.

The carbohydrate analysis of the leaves and of the culms and roots of the unmanured plants and the plants manured in the above-mentioned manner at five different dates are made. The hexoses, cane sugar and starch were estimated in each case separately from the leaves and from the culms and roots. Interesting results are obtained which will be discussed.

21. Photosynthetic activity of the leaves of the rice plant.

R. H. DASTUR *and* J. J. CHINOY, Bombay.

As no data has been collected so far as the authors are aware, about the photosynthetic activity of the leaves of the rice plant by direct measurements, this work was undertaken to measure the rate of photosynthesis of the leaves of the rice plant at different stages of growth.

The photosynthetic activity of the leaves in this investigation is measured in two ways, (1) by determining the carbohydrate contents of the leaves in the morning and in the evening, and (2) by measuring the absorption of carbon dioxide from the air under controlled and uniform conditions of experiments.

In the first method the leaves are killed and extracted with alcohol with necessary precautions. The sugars are then separated from other substances. The starch is hydrolised by taka-diastase and is converted into dextrose and maltose.

All sugars are estimated as hexoses. Cane-sugar and maltose are hydrolysed to hexoses before estimations. A calorimetric method of estimating sugars first used by Follin and Wu and subsequently modified by other workers is used in this investigation with further modifications.

A sample of leaves is taken in the morning and is analysed for carbohydrates. Another sample is taken the same evening and is similarly analysed. 20 such double carbo-hydrate analysis of the leaves are made on different days from July to October. On two occasions the leaves are analysed from carbo-hydrates every six hours during 24 hours.

In the second method carbon-dioxide absorption of the leaves of the rice plant is measured by the continuous gas current method. A special leaf chamber to hold four leaves of the rice plant is devised. Ordinary air is used and is circulated through the leaf-chamber at the rate of about 100 litres per hour. The carbon-dioxide of the air is estimated before and after it passed through the leaf-chamber in two sets of absorption apparatus consisting of Reiset Towers containing $NaOH$ solution of known strength.

From the results obtained by the two methods the following periodicity in the photosynthetic activity of the leaves of the rice plant is noticed. The photosynthetic activity rises rapidly, soon after transplantation, *i.e.*, after about 8 days. It remains fairly uniform in August after which there is a depression in September. There is a sudden rise in the photosynthetic activity in October and it reaches its maximum during that period. There is a big fall in the rate of photosynthesis soon after.

The same features of the photosynthetic activity are noticed in the results obtained by the two methods.

22. Growing of gaorani *Bani* cotton in Hyderabad state.

K. SAWHNEY *and* D. V. NARAYANAYYA, Parbhani.

Until a few years ago, *Hyderabad gaorani* (*Gossypium indicum* Lamk.) was the chief variety grown in the Mahratwada districts of H. E. H. the Nizam's Dominions.

Indiscriminate importation of seed of more prolific short stapled varieties from Berar seriously lowered the quality of *gaorani* cotton through admixture. At the present day except in areas far away from the railway line, the *gaorani* crops contain a mixture of *namburi* (*Gossypium hirsutum*), *rosea* and *cutchica* varieties.

H. E. H. the Nizam's Department of Agriculture is making efforts to rehabilitate the *gaorani* variety by

(1) distribution of seed (procured from areas famous for *gaorani*) on *takavi* loans to cultivators;

(2) by declaring the districts of Nanded, Bidar and part of Adilabad as 'Protected Area' under the Hyderabad State Cotton Transport Act;

(3) by the botanical improvement of *gaorani* cotton with financial assistance from the Indian Central Cotton Committee.

The cultivation of *gaorani* cotton is described with reference to soil, climate, cultural practices, methods of sowing, plant habit, yield and economic characters. The most common insect pests and diseases are also mentioned.

It is concluded that with the continuation of the present efforts of H. E. H. the Nizam's Department of Agriculture and the Indian Central Cotton Committee, it will not be long before the desired results are achieved.

23. A preliminary note on the effect of sowing date on growth, flowering and yield on *Bani* (*G. indicum*, Lamk.) plant.

K. SAWHNEY *and* B. B. MULCHANDANI, Parbhani.

In order to determine the effect of different sowing dates on the yield of *Bani* cotton at Parbhani, individual small beds were sown in 1929 with the seed of *Bani 306*. Sowings were made on 24th June, 10th July, 10th August and 19th August at the Cotton Research Station.

Crop sown in the month of August remained stunted, produced but few flowers and matured no ripe bolls. Plants sown on 24th June attained a height of over four feet as against less than three feet for the sowing of 10th July. The number of flowers and bolls produced by plants sown in June was nearly twice that of the plants of 10th July sowing. The yields of seed cotton per bed was also in the same proportion.

The August sowings were found to be undesirable, and June sowing distinctly better than sowing made in July.

It is suggested that where the cost of planting seed is only a minor consideration, the risk involved in sowing after the first shower of about an inch and a half is well worth taking. From the study of the daily rainfall records of the past two decades it is surmised that such a step would invariably prove successful.

24. A note on the development of buds, flowers and bolls of *Bani* (*G. indicum*, Lamk.) cotton in relation to branching.

K. SAWHNEY *and* B. B. MULCHANDANI, Parbhani.

Development of buds, flowers and bolls of *bani* cotton in relation to branching was studied at Parbhani (Deccan) in 1929. The investigation was financed by the Indian Central Cotton Committee.

Sown on 24th June the plants produced their first buds at the end of July. Buds were produced in two flushes: one lasting from the beginning of August to the third week of September, and the other from middle of November to middle of December. Most of the flowers and all the ripe bolls developed from the buds of the first flush.

Flowering started on 21st August. Flowers on the successive nodes on a primary fruiting branch appeared at intervals of 7·67 days, and on corresponding nodes of successive fruiting branches at intervals of 2·53 days.

The early flowers were the most successful in setting fruit. Flowers formed up to 10th October produced 80 per cent. of the ripe crop. Fifty per cent. of total flowers matured into bolls.

Ninety-three per cent. of total bolls were produced by primary fruiting branches, and an overwhelming majority were borne on their first two nodes.

The mean maturation period of buds was $30·7 \pm ·339$ days and for bolls $42·6 \pm ·354$ days.

25. A note on the root-system of *Bani* cotton.

K. SAWHNEY *and* D. V. NARAYANAYYA, Parbhani.

A preliminary study of the root-system of *bani* cotton was carried out at the Cotton Research Station, Parbhani, in 1929-30. The roots of a set of six plants of Bani 306 in three consecutive dibbles were exposed by slowly washing away the surrounding soil.

The main features of the roots exposed were as follows:—

(*a*) The abrupt ending of the tap root at a depth of six to eight inches,

(*b*) The virtual absence of branch roots from the adjoining surfaces of the tap roots of the plants growing in the same dibble, and

(*c*) The confinement of the majority of the tertiary roots to the first two feet of soil.

It is surmised that the superficial distribution of roots was due partly to the existence of the hard pan formed by the repeated use of the blade-harrow, partly to the wide spacing adopted and partly to the heavy rains late in the season.

The one-sided appearance of the root-systems is believed to have resulted from the juxtaposition of two plants in the same seed hole.

26. Some observations on the 'Red Leaf Blight' of cotton.

K. SAWHNEY, Parbhani.

Red Leaf Blight of cotton has been known in Hyderabad since long as a malady of *Buri* (*G. hirsutum*) plants which usually constitute an appreciable portion of the *bani* mixture now grown. It has been ascribed to all sorts of soil and climatic causes, but it was only in 1929 that this trouble was found definitely associated with an attack of jassids. Heavily attacked plants when protected against jassids resumed normal growth and fruiting, but on removal of the protection they again suffered from these insects and developed the usual symptoms of Red Leaf Blight. Varietal difference of resistance to jassids were observed. It is pointed out that the hairless condition of the leaf is not always associated with susceptibility to jassids. It is also suggested that the palatability of leaf-juice is probably one of the chief factors that determine the preference of jassids for a particular variety. The failure of past efforts to introduce American varieties in this region seems to have been due at least partly to the activity of jassids. Breeding of a type resistant to jassids will very likely solve the problem.

27. Some observations on the Dry Rot (sore-shin) of cotton.

K. SAWHNEY *and* D. V. NARAYANAYYA, Parbhani.

Owing to inadequacy of available area at the Cotton Research Station, Parbhani, the majority of the cotton experiments of 1931 season had to be carried out in plots that had been under cotton in the preceding year. Dry rot or 'sore-shin' (*Rhizoctonia bataticola* (Taub.) Butl. took a heavy toll in the experiments' crop. Mortality record showed that the loss was greatest in plots where cotton had been grown for a second time in succession and lowest where soil had been left a ploughed fallow in the previous year. In addition, varietal differences of susceptibility to the disease were noticed. A few strains were found to be comparatively resistant.

This investigation was made as part of the cotton improvement work which is being financed in Hyderabad State by the Indian Central Cotton Committee.

28. A note on the effect of fallow borders on the yield of cotton experiment plots at Baghdad.

K. SAWHNEY, Parbhani.

An investigation into the effect of fallow borders on the yield of cotton experimental plots was conducted at the Government Experimental

Farm, Baghdad, in 1924. The statistics recorded for the 18 varieties included in the investigation gave the following findings :—

(*a*) The maturation of the plants of the border-rows was appreciably delayed.

(*b*) The yield per border-row of every variety was markedly greater than its yield per central-row.

(*c*) The excess of the mean yield per border-row over the mean yield per central-row varied from 35·7 per cent. to 54·8 per cent. of the central-row yield and was statistically significant for 16 out of the 18 varieties grown.

(*d*) The effect of borders on plot-yield was not uniform for all the varieties. The maximum effect was shown by those varieties which were characterised by shortness of stature and marked lateral growths of plants.

It is, therefore, concluded that the exclusion of border-rows from the plots of varietal experiments with cotton will make the plot-yields more truly representative of the yielding power of the varieties tested and will enhance the accuracy of varietal comparisons.

29. On the production of secondary root-hairs on old root-stocks of Cambodia (*Gossypium hirsutum*).

T. C. N. Singh, Benares.

Cambodia is one of the important cottons which has been engaging the attention of investigators on account of the physiological disease (Red leaf blight) from which it suffers so very considerably. It is interesting to note that root-washings of these plants have shown a peculiar phenomenon in the fact that root-hairs have been found (secondarily formed) on old root-stocks in quite a great abundance in addition to those which occur normally a little behind the root-tips. The root-hairs thus formed as usual like the normal root-hairs, are elongate and unicellular with one nucleus in each.

The significance of this important physiological phenomenon is discussed in the fuller paper.

30. Origin of lint and fuzz hairs.

V. Ramanatha Ayyar *and* G. Seshadri Iyengar, Coimbatore.

Examinations of the microtome sections of cotton ovules of different ages have revealed that (1) formation of lint cells are predetermined and the differentiation in the epidermal cells occurs even 16 hours before the opening of the flower, (2) the rate of development of these cells varies with their location in the peripheral layer of the outer integument, (3) crops of hairs continue to be produced even after the day of flowering, and that (4) a second kind of hairs is produced from the subepidermal layer 12 days after flowering. It is suggested that the latter corresponds to the fuzz of the mature seed.

31. Immaturity of cotton fibres in relation to the position of the seed in a lock and the length of fibres.

V. Ramanatha Ayyar *and* R. L. N. Iyengar, Coimbatore.

The various factors that influence the production of immature fibres are analysed but particular attention is paid to the examination of immaturity in cotton in relation to the position of the seed in a lock and length of fibre.

Three cottons—two of Cambodia, viz., Co. 1 and Co. 2 and one of Karunganni, Strain 546, were examined. The results have been studied by

the method of the analysis of variance under three heads, viz., (1) Ripe, (2) immature, and (3) thin-walled fibres and the following are the conclusions arrived at.

(1) There is a definite relation between the length of fibres and the proportion of immature and ripe fibres.

(2) The direction of this relationship varies with the type of cotton. In strain 546 immaturity increases with decrease in length while in Co. 1 and Co. 2 it varies in the opposite way.

(3) Every increment in length does not produce equal increases or reductions in the percentage of ripe fibres.

(4) The distance from the pedicel end does not bear any relation to the proportion of ripe and immature fibres. Yet each seed in a lock acts as an independent distributing centre and produces a definite influence on the production of immature and ripe fibres.

(5) Group lengths induce greater variation in the distribution of ripe fibres than the position of the seeds, while it is the positions that contribute to the greater variability in the percentage of immature fibres, in Cambodia cotton.

(6) There is a definite interaction between the position of the seed and the length of fibres. This relation influences the proportion of immature fibres borne on the seed.

32. Variation in the physical properties of fibres situated in the different regions of the seed-surface.

R. L. N. Iyengar, Coimbatore.

The surface of a seed of seed cotton was divided into six regions, viz., (1) the micropyle end, (2) the portions close to the raphe, (3) the right side, (4) the back, (5) the left side, (6) the chalazal end. Fibres from each of these regions were pulled out by hand and the following fibre-properties, viz., (*a*) fibre-length, (*b*) fibre-weight per cm., and (*c*) immaturity were determined for them.

When the results were examined the following conclusions were evident :

(1) *Fibre-length.*—The micropylar end contains fibres significantly shorter than at the other portions, among which no variation is noticed.

(2) *Fibre-weight per cm.*—The micropylar end has the greatest fibre weight often more than double that of the chalazal end which records a very low weight. Among the other regions there appears to be no conspicuous difference. The combed waste shows a low fibre-weight.

(3) *Immaturity.*—The micropylar end contains a high percentage of ripe fibres and a small one of 'dead' and thin walled fibres. On the contrary the chalazal end contains a high percentage of 'dead' fibres. The immaturity in the other regions shows no great fluctuation. The combed waste has a high percentage of immature fibres.

(4) An examination of the results, with a view to find out whether the high percentage of immature fibres at the chalazal end would be sufficient to explain the low fibre-weight at that place, showed that it could do so only if the fibre-weight of the 'dead' fibres was very small compared with that of the ripe ones.

33. A new variety, and inheritance of certain characters in cotton.

R. Balasubramanyan, Coimbatore.

The paper describes an isolated type of cotton, breeding true and differing in many characters from the type description of *G. obtusifolium* Roxb. The variety possesses creamy pollen as against the common lemon yellow of the other described Asiatic cottons. The difference in pollen colour is recorded for the first time in Indian cottons.

The inheritance of pollen, and lint colours are followed up to the second generation in a cross with a strain from *G. obtusifolium* Roxb. and the results indicate simple monohybrid ratios with cream and yellow as allelomorphs in colour of pollen, and white and light red, in colour of lint. Identical results obtained in back-crosses confirm the above conclusions.

34. Variation in the yields of coconuts and its causes.

J. S. PATEL *and* K. W. CHAKRAPANI MARAR, Coimbatore.

A coconut tree normally carries three years' crop in its crown. The rainfall of one year influences the crop production in the third year by affecting the female flower production.

Yearly yields of coconuts are correlated with north-east monsoon rains of two years and hot weather rains of the year previous to the harvest.

These rains benefit the crop by increasing the bunch and female flower production. The percentage of setting is low during wet months.

It appears that substantial increase in the yield of coconuts could be effected by irrigating palms during dry weather.

The trees in a coconut plantation could be classified into heavy, medium or poor bearers according to their average yields. These groups appear to be genetically different.

Alternate-bearers yield heavily in alternate years. Other irregular-bearers are erratic in their yields.

35. The value of local varieties in plant breeding and the danger of losing them.

G. L. KOTTUR, Dharwar.

India is agriculturally one of the oldest countries in the world. Many of her crops are cultivated from times immemorial and as a result of this they are highly acclimatised. The farmer generally sows his own seed and sometimes he even selects it. But his crop is genetically very complex being a mixture of many types. By selecting the high yielding types the varieties have been improved in many cases by present-day breeders and these improved varieties are now replacing the old ones. The latter still contain much valuable material which has a use in breeding. Very often it includes such characters as resistance to disease which are noticed only in certain years. In such cases the local varieties come to the rescue when the improved types fail all of a sudden. Again the breeder has to select his variety or type not only for one character but for many other characters also. This is possible only when the number of varieties and types is large. For all these reasons it is desirable to maintain the local varieties and something requires to be done in this direction before they are completely ousted.

ANIMAL HUSBANDRY (Including Pastures).

36. An experiment on mineral assimilation from two typical fodders.

F. J. WARTH, A. VISWANATH IYER, *and* N. KRISHNA AYYAR, Bangalore.

In this experiment two fodders, namely, Ragi straw and hay were compared. Four bullocks were maintained on each fodder. The experiment was divided into three main periods.

1. A long period on the fodder without mineral supplement.

2. A period in which the fodder was supplemented with Calcium Phosphate. This test was intended to determine whether assimilation could occur in the absence of green fodder vitamins.

3. A period in which the fodder was supplemented with Calcium Phosphate and green food. This test was intended to determine whether the addition of green fodder led to further assimilation.

During each period numerous determinations of the mineral balance were made. The following points have been established :—

(1) The Ragi straw samples contained more lime and P_2O_5 and also gave better assimilation than the hay sample. Assimilation of these minerals is therefore very largely dependent upon the amount present in the food.

(2) During a long continued feeding test there is a strong tendency towards diminishing assimilation, resulting in negative balances.

(3) Feeding of Calcium Phosphate at this stage led to marked assimilation of P_2O_5 in the absence of green fodder vitamins. The evidence relating to lime assimilation is not clear.

(4) The addition of green fodder vitamins did not bring about further assimilation of P_2O_5 or lime in the case of the Ragi straw ration. In this case the losses of these ingredients were therefore made good by feeding Calcium Phosphate alone.

37. An experiment to determine the effect of hippuric acid excretion on the nitrogen balance.

F. J. WARTH *and* N. C. DAS GUPTA, Bangalore.

Previous work by us has shown that hippuric acid production is dependent upon the fodder. Certain fodders produce large amounts, while other fodders produce small amounts. Two fodders were selected yielding large and small amounts respectively.

A long period feeding test was carried out with these two fodders using four bullocks for each. Periodically the amount of protein was varied, sometimes increased, sometimes decreased. The nitrogen balance was determined at each stage.

The experiment shows definitely that more protein is required to maintain a nitrogen balance, when the hippuric acid excretion is high. Full data are given.

38. Silage investigations at Bangalore.

T. S. KRISHNAN, Bangalore.

Effect of the stage of maturity on the ensilage of Jowar.

Ensilage of Jowar (*Sorghum vulgare*) was carried out at the following stages of maturity :—

1. Immature.
2. Prime.
3. Dead ripe.

In all cases the changes taking place in the various organic and inorganic constituents during ensilage were followed. The effect of varying the filling conditions on the quality and yield was also investigated.

With the immature plant, the silage, though relished by cattle had a tendency to become sour. With the prime plant and the dead ripe straw, however, good brown silage well relished by cattle, was produced.

The dry matter losses were about the same in the various pits in spite of the wide variations in the stage of maturity of the plant. The different constituents, however, showed variations in the degree of loss according to the age of the plant at the time of ensilage.

The inorganic constituents, however, behaved not very differently in the various stages of maturity.

The best silage was obtained from the prime plant, though the process had the most beneficial effect on the dead ripe straw.

39. Preliminary experiment on the digestion of fats.

P. A. Seshan, Bangalore.

The nature of the fat ingested and the corresponding fat excreted in a number of feeding experiments has been studied.

Considerable differences have been noted. The data obtained indicate that certain fractions of the food fat are more readily assimilated than others. For example it has been found in several cases that the unsaturated fatty acids are very readily assimilated, whilst generally the unsaponifiable matter appears to escape assimilation to a great extent.

40. A study of pastures and meadows at Hosur.

T. Murari, Hosur.

Introduction.—Classification of existing pasture in this country and at Hosur.

Types of grasses.—Botanical survey of grasses in the different types of pastures.

Quality and quantity of pastures.—Discussion of factors affecting same. Competition between species explained.

Study of root system of grasses.—A preliminary study made.

Manurial experiments.—Explained.

Intensive manuring and intensive system.—Experiments discussed.

Artificially dried grass.—Process and feeding experiment explained.

Silage and hay.—Explained.

Grazing, effect of fencing and palatibility.—Pasture complex and animal complex discussed.

41. The necessity for more extensive scientific development, closer co-operation and strict specialization in Animal Husbandry work for the proper economic exploitation of Livestock and Animal products in India.

A. Olver, New Delhi.

After indicating that financial provision for Animal Husbandry work is far greater in other countries, proportionately to the number of domesticated animals maintained, the author gives figures to show how immensely valuable animal products are to India and how inadequate the present arrangements for Livestock Improvement are. He shows that far greater economic benefit has been obtained from livestock in countries where animal industry has been developed on modern scientific lines, under the direction of scientifically trained specialists in Animal Husbandry. Emphasis is laid on the pressing need for closer co-operation of all the departments concerned with livestock in India and the necessity for independent budgetary provision for Animal Husbandry work of all kinds so that reasonable certainty may be assured, for carrying through such long range co-ordinated programmes of livestock improvement as are essential to success in dealing with the large slow breeding animals of the farm.

AGRICULTURAL ZOOLOGY.

42. Bionomics of some thrips injurious to cultivated plants in South India.

T. V. Ramakrishna Ayyar, Coimbatore.

Until about fifteen or twenty years ago our knowledge of the insects known as 'thrips' inhabiting the Indian region was very meagre, and

consequently hardly anything was known of the economic importance of these animals. This might be realised from the fact that in 1915 when the writer started work on the systematics of this group, there were altogether only fourteen species of 'thrips' known from India as against 126 species listed by the writer in 1927 in his memoir and a further addition of sixteen species in a recently issued paper. In this connection it may be gratifying to note that the earliest record of 'thrips' from India was from specimens collected in this state (Mysore) and described by Newman in 1856. As regards the economic aspect of the group it is further evident that previous to 1915 we find only a solitary record of a definitely named 'thrips' noted as injurious to a crop, and that was in connection with a report sent to the Indian Museum by the Madras Board of Revenue of a thrips attacking the turmeric plant in Madras in 1889; this insect remained unidentified for over 20 years until 1912 when it was described by Bagnall as a new species. Since then no thrips of any economic importance was recorded from S. India for many years. In 1915 the second 'thrips' pest was discovered by the writer on paddy in Chingleput and this was described as a new species by Williams. Closely following this second record, in the course of the writer's studies it became possible to note some more forms possessing some agricultural importance; and with the then data available a paper was read before the recent session of the Congress at Madras in 1929 under the title 'The economic status of Indian Thysanoptera' containing an annotated list of thrips noted on various plants in S. India.

This present paper which embodies some of the results of further studies in the same direction is intended to present in a connected and brief manner some of the observations and notes made on the bionomics of some of the S. Indian species which have been found so far to deserve the status of pests.

Following a few brief remarks on the general organisation and the habits of thrips in general the author deals in a non-technical manner with the bionomics of about a dozen species of S. Indian thrips which have been found injurious to cultivated plants. Some notes are also added on the possible lines of control measures against injurious forms based on experience so far gained. The paper concludes with a few observations on the necessity for better and further knowledge of these little known insects especially of the injurious forms in view of the fact that some of them are becoming important pests and also in view of the possibility of some of them becoming vectors of virus diseases of some important plants.

The species dealt with include :—

1. Chillies thrips—*Scirtothrips dorsalis H.*
2. Onion thrips—*Thrips tabaci L.*
3. Rice thrips—*Thrips oryzae W.*
4. Grape and rose thrips—*Rhipiphorothrips cruenatatus H.*
5. Sugarcane thrips—*Bregmatothrips Ramakrishnae B.*
6. Banded-wing thrips—*Heliothrips indicus B.*
7. Cacas thrips—*Selenothrips rubrocinctus G.*
8. Green house thrips—*Heliothrips haemorrhoidalis B.*
9. Turmeric thrips—*Panchaetothrips indicus B.*
10. Mimusops thrips—*Arrhenothrips Ramakrishnae H.*

43. A fish pest of fields along the Coromandel coast.

T. V. Ramakrishna Ayyar, Coimbatore.

While many of us are aware of the injury occasionally caused to paddy fields by crabs in different tracts, especially in some of the delta tracts of the Coromandel coast, it might be a surprise to at least some of us to be

told that there is a fish which has been noted as injurious in some of these tracts. This creature which is known as '*Anakuthupampu*' in tamil (and the damage it causes being known as *Ramasuli* in Telugu) is an elongated flattish creature generally believed to be a water snake. The animal is really a fish and belongs to the group of fishes called 'eels'. This creature generally inhabits the estuaries and tidal streams along the coast and is often found to travel inland into the channels and streams during ebb tide. Though it has been noted as a pest till now only in the coast of S. Arcot and in the Godaveri delta, the creature has a wide distribution and is one of the commonest species of eels found along the Indian coasts.

The nature of damage done by this creature does not, as in the case of most other pests, consist in any direct injury by the creature feeding on the plants or causing them any mechanical injury, but it is an indirect harm caused by numbers of these eel fish burrowing into and making wide passages connecting the paddy fields containing fresh water on one side and the adjacent salt water channels or tidal streams on the other. This causes the salt water from these latter to enter the paddy fields and affect the growth of the plants; due to the ill effects of salt water the plants get scorched and often die. The damage is thus described by a cultivator near Chidambaram :—'The snake bores through the flat bund of the uppanar eleven feet wide-under-ground and gradually the bund weakens in several places causing sudden breaches allowing inroads of salt water getting into the paddy fields and polluting the clear water on account of which the plants become scorched and finally wither; lands to the extent of 500 acres are thus affected by the overflow of salt water through holes and passages made by the snakes called 'Anakuthupampu'. Though it was only recently that this creature was reported as a pest in paddy fields, it was known to the writer as a pest in a different role as early as 1918. In March 1918 a report was received from the Commissioner of Salt and Abkari, Board of Revenue, Madras, to the effect that some of the salt pans and condensers in Ganjam and Godaveri were being damaged by crabs and a burrowing creature causing injury known as *Ramasuli* in Telugu. The writer had the privilege of visiting these tracts to investigate the reported damage in April 1918 and it was then that this *Ramasuli* pest was found to be an eel-fish and evidently the same as the *Anakuthupampu*! The injury caused to salt pans by this creature consisted in the brine, which is let into the salt pans and condensing plots for evaporation and salt deposition, getting drained off through the holes and passages made by crabs and eels either into the subsoil water or into the adjacent salt water channel; in this way no salt is allowed to be deposited. Thus this eel has been noted both as a pest of salt pans and paddy fields.

This eel fish has been definitely named as the common boring eel *Opichthus boro*. In this paper brief remarks are added on this creature—the damage it causes and possible suggestions for control. The main object of the paper is to bring to the notice of agriculturists the existence of such a novel pest so that any one having opportunity to come across this creature in future may be able to add to our knowledge of the habits of this little known creature and devise really effective methods of control.

44. Pests of Ganja (*Cannabis Sativa*).

M. C. CHERIAN, Coimbatore.

The paper deals with the pests of the Ganja crop the more important of which are *Tetranychus telarius* (Mites), *Chloridea obsoleta* and *Amyna octo* (Caterpillars), *Microtermes obesus* (white ants) and *Dolycoris indicus* and *Nezara viridula* (plant bugs). Detailed life-history notes and remedial measures are given for these pests, especially the mites. Short notes are also given on the other pests.

45. The Cholam Mite (*Paratetranychus indicus*) on Sorghum).

M. C. Cherian, Coimbatore.

A detailed study is made of the Cholam Mite under the following headings :—

Life history,
Parthenogenesis,
Method of spread,
Amount of loss,
Distribution in the Madras Presidency,
Alternate host plants,
Effect of weather conditions,
Natural enemies, and
Methods of control.

46. Some experiments on the control of the root-gall nematode *Heterodera* (*Caconema*) *radicicola* (Greef) Muller in South India.

P. N. Krishna Ayyar, Coimbatore.

The study of the plant feeding nematode *Heterodera* (*Caconema*) *radicicola* has been little advanced in this country in spite of its great economic importance. During the past nearly ten years the writer has been, though intermittently, bestowing some attention towards the study of this pest in all its bearings including methods of control. The results of some preliminary observations have been recorded in a previous paper on the subject contributed to the Indian Science Congress in 1925. In that paper the main features in the life history of the pest, its occurrence and distribution in South India, the symptoms and nature of the disease caused, with its range of host plants in South India have been briefly outlined. It is the aim of this paper to present the results of further studies as also of certain preliminary experiments conducted during 1924 to 1926 in combating the pest under South Indian conditions. Perhaps this experiment on its control is the first of its kind attempted in India. The experiment includes various treatments by chemical, heat and cultural means of the infested soil in order to find out the most effective weapon of fighting it. The results obtained, though admittedly unsatisfactory and inconclusive in some respects, have served to throw some light on various fundamental factors involved in its control. It is evident that though the pest cannot be completely eradicated by these methods, the population of the nematodes and consequently the damage to economic crops can be greatly reduced by such means though for temporary and varying periods. The relative values of the different treatments are indicated as far as could be ascertained from the few trials made. Among these such methods as partial sterilisation, trap crop, lime, formalin and carbon bi-sulphide have been tentatively observed to show increasing efficacy in the order of enumeration.

The writer has also noted some plants which may be described as non-susceptible or nematode-resistant in South India. Among these Cholam, Red gram and Maize may be mentioned which can be utilised to advantage for crop rotations in heavily infested localities so as to sterilise soil gradually by starving out the nematodes in the soil. A detailed study of the host-history of the particular population of *Heterodera radicicola* experimented with, has been made along with some aspects of the conditions favourable to its multiplication and means of dissemination in South Indian conditions. A more or less exhaustive list of substances tried in various parts of the world by past investigators in soil sterilisation is added indicating their concentrations and relative efficacy wherever possible. Further notes on its distribution and the extended range of host plants recently noted, have also been presented.

47. The coconut caterpillar *Nephantis serinopa* Meyr. in Cochin.

C. S. VENKATASUBBAN, Trichur.

The pest *Nephantis serinopa* Meyr. first appeared in Cochin State in the year 1924, all along the coastal regions. There is evidence to show that it has come from Kayamkulam, a centre of infection in the adjoining Travancore State, along with coconut fronds carried by the phenomenal floods which occurred in these parts in August, 1924. Nearly a lakh of coconut trees were severely affected, all except the few topmost leaves being dried up and skeletonized. The infection was successfully combated by the removal and burning of all the infected leaves. This operation killed none of the trees and they regained their health and productivity in two years. Parasites *Stomatoceres sp.*, *Elasmus sp.*, *Microbracon sp.*, *Bethylid sp.*, and *Eulopid sp.* are present, besides two predators, a carabid beetle, and an anthocorid bug. Under normal conditions these keep the pest under control, but during the hot months their numbers are considerably reduced. This explains why the pest increases and spreads after every hot season. Since 1924 the history of the pest has followed a more or less regular course, viz., fresh outbreaks at the close of every hot season, and subsidence during the rest of the year. Operation of the trees soon after a fresh attack, reduces the pests greatly without appreciably affecting the number of its enemies. These natural enemies alone can control the pest, but the process is rather slow, and there is the danger of its spread to new areas. The above treatment helps to obviate these difficulties. As a result of the vigorous campaign of the State Agricultural Department, the pest is now not so serious as before

48. Manurial requirements of lac hosts.

S. RANGANATHAM, Namkum.

The successful and continuous exploitation of host trees for lac crops would require periodical additions to the soil of such of the fertilising elements as are removed in the crops. The relative importance of particular manures would also depend on the species of host utilised Brood lac collected on Kusum Khair and Palas trees for two or three seasons have been analysed, separately as refuse sticks and lac encrustation, for inorganic constituents. From the analytical data obtained the probable role of Calcium and Phosphorus in lac cultivation has been indicated. An approximate estimate of the loss to the soil of the different nutrients has been worked out for each of the three hosts.

49. Comparative study of lac hosts with special reference to *Acacia Catechu* and *Cassia florida*.

A. K. THAKUR, Namkum.

Comparative study of the two hosts was made both biochemically and morphologically. From the point of view of the chemical analysis of the two plants, it was found that the bad host, e.g , *Cassia florida* gave higher figures than the good host—*Acacia Catechu.* The sap in *Cassia florida* was found to be more acidic than that in *Acacia Catechu*; similarly the sap-density of the former was greater than that of the latter. Other host plants were tested for these factors and similar results were found.

50. Agricultural economics of pig campaign costs.

P. N. BHIDE, Poona.

The note is meant to dispel the impression that the Agricultural Department's pig-work is very costly. The impression is due to taking the

'kill' for calculating costs as basis. Why this basis is not proper and what should be the proper basis is pointed out.

It is stated that money spent by people readily is no additional burden but a cheap insurance by which the following results are obtained :—

(1) better health of community;
(2) tremendous diminution of anxiety of night-watching;
(3) assurance of hitherto precarious food-supply.

The results (immediate and remote) on pig and on crops and ultimately in better condition of the farmer are explained and illustrated.

Definition of cost per 'kill' is attempted; averages of all campaigns and each campaign in the three typical covers in Deccan are shown on graphs and campaign periods and continuous working is explained. What items are constant and what are the variables in the actual cost are explained with reasons and how attempts are made to economise still further the actual cost is explained.

An instance is given of the limit that farmers would go to in killing one pig.

The note concludes with a statement 'substantial help is given by Government in bearing all supervision charges and also part expenses'.

BACTERIOLOGY.

51. Studies on bacteriophages of the root nodule organisms.

S. V. Desai, Pusa.

A method has been evolved by which bacteriophages have been isolated from roots of many leguminous plants. Various media have been tried and it has been established that media suitable for isolation of the bacteriophage are unsuited for enhancement of virulence and *vice versa*. The formation of plaques has been invariably observed. Two types of plaques have been met with. The formation of two different types of plaques depended upon the kind of the growth of the organisms and the previous history of the bacteriophages and not on the inherent nature of the bacteriophages. The bacteriophage giving one type of plaques may be made to give plaques exactly like the other type when grown with a suitable strain of the organisms showing that all bacteriophages of the nodule organisms represent one primary bacteriophage.

Bacteriophage of these organisms showed a modified form of Twort's phenomena which took place when a colony of the organisms was touched with the bacteriophage. The appearance of the colony changed from raised, opaque, pearly white, slimy and glistening one to flat, transparent, bluish and slightly granular one. The bacteriophages were not particularly specific in their action. Not only all the strains of the corresponding organisms were attacked but the bacteriophages could be trained to attack any organism derived from widely different species of leguminous plants. The bacteriophages were heat labile and a temperature of 75°C. for 5 minutes served to inactivate them. The progressive rate of lytic action showed that organisms were at no time completely destroyed even when the bacteriophage was of maximum virulence. Secondary growth occurred in all liquid cultures which had become clear by the action of the bacteriophage. Secondary cultures showed some resistance to the action of the bacteriophage but they lost this resistance if cultivated for one germination in absence of the phage. The separation of the organisms from the bacteriophage was difficult; only repeated planting was successful if the contact of the organisms with the bacteriophage was not of long duration.

METEOROLOGY.

52. A preliminary note on the meteorological conditions at Parbhani (Deccan).

K. Sawhney *and* V. K. Bederker, Parbhani.

Air and soil-temperature records collected at the Cotton Research Station, Parbhani, in the year ending 31st August, 1931, and rainfall records for the last 22 years were analysed to form a connected idea of the climate of the locality. The results of the examination may be stated as follows :—

(1) March, April and May are the hottest months of the year. With the arrival of the monsoon early in June the weather becomes temperate, and, except for a spell of heat in October, remains so for the rest of the year. There is no real cold weather. The lowest temperature of the year (42°F) was recorded on 22nd December.

(2) Except during the hot season, the soil temperatures invariably increase with the depth. In hot weather the temperature at one-foot depth is higher than at greater depths. Temperature below one-foot level shows a narrow annual range.

(3) Average annual rainfall is 33·48 inches. Over four-fifths of this is received from June to September. North-east monsoon contributes a minor and highly erratic proportion of it.

(4) From mid-April to mid-October the wind-direction lies between south-west and north-west; in the remaining period it fluctuates between south-east and north-east.

(5) Relation of climate to crop production is briefly indicated.

STATISTICAL METHODS.

53. Some statistical deductions arising out of the past and the present wheat position in India.

M. Vaidyanathan, Simla.

Present world wheat position—statistics of production, net exports or imports of wheat in the chief countries involved in wheat trade (graphs). Available statistics of utilisation of wheat in the various countries. Indian statistics of production, net exports or imports of wheat for the past thirty years (graphs). Estimates of consumption of wheat in India based upon a statistical 'fit' to a long series allowing for the change in population. Estimates of stocks and carry over of wheat in India by a process of triennial averages. Statistics of *per capita* utilisation of wheat, and competing crops (Rye, Maize and Rice) in several countries. World's wheat crop in relation to prices at Liverpool and Karachi from 1904–1931. Statistical relations between the monthly prices of Manitoba at Liverpool and the progress of arrivals of American, Australian and Argentine wheat. Multiple correlation between the Liverpool price and (1) estimated world stocks, (2) world production, and (3) movement. Weekly prices of Punjab wheat at Karachi for the past thirty years graphically illustrated. Statistical relation between wheat prices and index number of general wholesale prices in India. Effects of elasticity of demand on prices based upon weekly arrivals at Karachi. Loss or gain by holding wheat till next crop (graphically illustrated). Statistical relation between spot and future prices in Karachi market. Points of agricultural interest, average produce per acre and cost of cultivation of wheat in some countries. A few aspects of recent progress in the cultivation of Indian wheat. Influence of milling and flouring of wheat in the wheat trade, with reference to Indian wheat. Incidence of railway and sea freights in the movement of Indian wheat (graphs). Some features of controlled marketing of wheat adopted in different countries. A few data on incidence of a differential cost to the producer of wheat at Lyallpur. Economic setting of the problem of wheat production and trade in India, and statistical inferences.

54. The effects of a plot arrangement on the estimated random error illustrated from Indian experimental data.

M. VAIDYANATHAN, Simla.

Introduction.—Methods of measuring systematic and random variations in terms of total soil variation in field experimentation. The effect of a systematic arrangement on the estimate of random error. Illustrations of Latin Square arrangements in Indian farms, affecting the estimates of residual variance. Estimates of systematic variation and random errors deduced from the Lyallpur Farm lay-out (replicated manurial experiments). Examination of the estimated errors in different kinds of scatter, such as (1) ABACABA, etc., (A control), (2) BCADEABACA, etc., (A control), and (3) BCDABCDA, etc., (A control), illustrated from Bihar and Orissa experimental results. The need for the introduction of a correction factor to eliminate the over-estimate or under-estimate of the random error in different schemes of lay-out. Suggestion of the spreading of plots to eliminate the error of this estimate. Conclusions.

55. A statistical note on the significance of certain rice-breeding experiments in the Central Provinces.

P. C. MAHALANOBIS, Calcutta.

D. N. Mahta and B. B. Dave recently published the yield figures of certain new hybrids reared by them (*Ind. Jour. Agri. Sc.*, Vol. I, Part III, 1931). In the present note these yield figures are analysed by R. A. Fisher's method of 'analysis of variance' and the significance of the results is discussed in detail.

56. A statistical note on the comparison of mean values based on small samples.

P. C. MAHALANOBIS, Calcutta.

The classical theory of errors is based on the assumption that the size of the sample is large. This theory cannot be legitimately used for the comparison of statistics based on small samples. A brief résumé of recent advances in statistical theory of small samples is given in the present note. Details of numerical calculations and new auxiliary tables are given, and the application of the method is fully illustrated by the comparison of the 'percentage success of flowers opening on bolls' for five different strains of Surat cotton for which the primary data were very kindly supplied by Mr. K. V. Joshi, Cotton Physiologist, Cotton Research Laboratory, Surat.

57. A first study of sampling experiments on the effect of systematic arrangements in field trials.

P. C. MAHALANOBIS, *and* S. S. BOSE, Calcutta.

Olof Tedin has recently shown (*Jour. Agri. Sc.*, Vol XXI, Part II) that systematic arrangements in a 5×5 Latin Square has a small but significant effect on the residual error. In the present paper it is suggested that this effect is due to the occurrence of patches of greater or less fertility which affect a few adjoining plots (and thus produce a small correlation between their yield) but are not large enough to extend uninterruptedly over appreciable portions of the field as a whole. Sampling experiments have been devised and made to test this possibility, and a preliminary report of expriments on a 5×5 Latin Square arrangement is submitted in this paper.

Section of Mathematics and Physics.

President:—PROF. GANESH PRASAD, M.A., D.Sc.

Presidential Address.

ON THE DIFFERENTIABILITY OF THE INDEFINITE INTEGRAL AND CERTAIN SUMMABILITY CRITERIA.

Introductory and Historical.

1. The subject which I have chosen for my address is the differentiability of the indefinite integral and certain summability criteria involving the question whether for a particular value of the variable a given indefinite integral has a differential coefficient. In order to make clear the type of problems to be considered by me this morning, I may mention the following:—

If $F(x)$ denote $\int_0^x f(t)dt$, does $F'(0)$ exist when

$$f(t)=\cos\frac{1}{t} \quad\text{or}\quad \frac{1}{t}\cos\frac{1}{t}\,?$$

Is Lebesgue's criterion for summability $(C\ 1)$, viz.,

$$\lim_{z=+0}\frac{1}{z}\int_0^z\left|\cos\frac{1}{t}\right|dt=0,$$

satisfied, for the case of the Fourier series corresponding to a function $f(x)$ such that

$$f(x+2t)+f(x-2t)=\cos\frac{1}{t}$$

in the neighbourhood of $t=0$?

2. The history of the problems typified above is rather brief. It was in the lectures, delivered at the University of Pisa by Ulissi Dini in the early seventies of the last century, that the question of the differentiability at $x=0$ of the indefinite integral $F(x)$ for an integrand $f(t)$ which does not give $f(+0)$ or $f(-0)$ was first considered. Dini emphatically asserted that $F'(0)$ could not exist in such a case and the assertion of Dini was equally emphatically endorsed by J. Thomae in 1875 in the first edition of his *Einleitung in die Theorie der bestimmten Integrale*. When Dini's lectures *Fondamenti per la teorica delle funzioni di variabili reali* was translated into German in 1892 and appeared as *Grundlagen der Theorie*

der Functionen einer veränderlichen reellen Grösse the opinion of Dini was reproduced * without any modification. It was only in 1893 that Thomae corrected his own and Dini's mistake in the paper, 'Ueber die Differenzierbarkeit eines Integrales nach der oberen Grenze', which appeared in the *Göttinger Nachrichten*, by proving that in some cases $F'(0)$ would exist even if $f(+0)$ and $f(-0)$ did not exist. For examples, Thomae gave

$$f(t)=\cos\frac{1}{t}, \quad f(t)=e^{\frac{1}{t}}\sin\frac{1}{t}.$$

In the year 1923, Dr. L. Narayan † studied the subject and soon after that I undertook a thorough investigation of the question.

As regards the validity of certain summability criteria, I may mention briefly the facts, that the criterion for summability $(C\ 2)$ was given by Prof. H. Lebesgue in the form

$$\operatorname*{Lim}_{z=+0}\frac{1}{2z}\int_{-z}^{z}\phi(t)dt=0$$

and that for summability $(C\ 1)$ in the form

$$\operatorname*{Lim}_{z=+0}\frac{1}{2z}\int_{-z}^{z}|\,\phi(t)\,|\,dt=0,$$

in each case $\phi(t)$ standing for

$$f(x+2t)+f(x-2t)-2S,$$

the Fourier series in question being that which corresponds to $f(x)$ and S being the Cesáro sum $(C\ 2)$ or $(C\ 1)$ as the case may be.

The first writer who expressed any doubt about the efficiency of Lebesgue's second criterion for a case like that in which

$$\phi(t)=\cos\frac{1}{t}$$

was Professor Leopold Fejér who stated in a paper published in the *Gött. Nachrichten* ‡ in 1925 that

$$\operatorname*{Lim}_{z=+0}\frac{1}{z}\int_{0}^{z}\left|\cos\frac{1}{t}\right|dt$$

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* See e.g., p. 368.

† See *Proceedings of the Benares Mathematical Society*, Vols. 4 and 5.

‡ 'Ueber die arithmetischen Mittel erster Ordnung der Fourierreihe'; see p. 2 of the paper.

did not exist, and that therefore nothing could be said about summability (C 1) in the case of

$$\phi(t)=\cos\frac{1}{t},$$

as Lebesgue's criterion was not satisfied.

Mistakes of a similar character were made in connection with criteria for strong summability by many other writers, including Professors T. Carleman,* G. H. Hardy, and J. E. Littlewood †, in papers published in the *Proc. L.M.S.* in 1927 and before.

Differentiability of the Indefinite Integral.

3. After giving you a brief introductory and historical sketch of the subject of my address, I proceed to consider the two parts of it separately and shall begin with the first part, viz., the differentiability of the indefinite integral.

That

$$F(x)\equiv\int_0^x \cos\frac{1}{t}\,dt$$

has a differential coefficient for $x=0$, is seen at once from the equation

$$F(x)=\int_0^x (-t^2)\,\frac{d}{dt}\left(\sin\frac{1}{t}\right)dt$$

$$=-x^2\sin\frac{1}{x}+\int_0^x 2t\sin\frac{1}{t}\,dt;$$

for, the part $x^2\sin\frac{1}{x}$ as well as

$$\int_0^x 2t\sin\frac{1}{t}\,dt$$

has a differential coefficient 0 for $x=0$.

4. Generally, if

$$f(t)=\cos\psi(t),$$

where $\psi(t)$ is monotone, we have $F'(0)$ existent or not, according as ‡

$$\psi(t)\succ\log\frac{1}{t^2}$$

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* *Proc. L.M.S.*, S. 2, Vol. 21.

† *Proc. L.M.S.*, S. 2, Vol. 26, pp. 273–287.

‡ See the note at the end of the address.

or
$$\psi(t) \precsim \log\left(\frac{1}{t^2}\right).$$

Proof:—

(*a*) Let $\psi(t) \succ \log \frac{1}{t^2}$.

Since
$$\frac{d}{dt}\left\{\frac{1}{\psi'} \sin \psi\right\} = \cos \psi - \frac{\psi''}{(\psi')^2} \sin \psi,$$
integrating both the sides of the above equality, we have
$$\frac{1}{\psi'(x)} \sin \psi(x) = \int_0^x \cos \psi \,.\, dt - \int_0^x \frac{\psi''}{(\psi')^2} \sin \psi \,.\, dt,$$
(as $1/\psi'$ vanishes at $t=0$ on account of $\psi \succ 1$),

i.e.,
$$\int_0^x \cos \psi \,.\, dt = \frac{\sin \psi(x)}{\psi'(x)} + \int_0^x \frac{\psi''}{(\psi')^2} \,.\, \sin \psi \,.\, dt.$$

Now consider
$$\operatorname*{Lim}_{x=+0} \frac{F(x)}{x}.$$

This equals
$$\operatorname*{Lim}_{x=+0} \frac{\sin \psi(x)}{x\psi'(x)} + \operatorname*{Lim}_{x=+0} \frac{1}{x} \int_0^x \frac{\psi''}{(\psi')^2} \sin \psi dt \quad \ldots \quad \ldots (1)$$

But, since
$$\psi(t) \succ \log \frac{1}{t^2},$$
$$\psi'(x) \succ \frac{1}{x},$$

i.e.,
$$x\psi' \succ 1; \quad \ldots \quad \ldots \quad \ldots \quad \ldots (2)$$

also
$$\frac{\psi''(t)}{\{\psi'(t)\}^2} \prec 1 \quad \ldots \quad \ldots \quad \ldots (3)$$
$$\left(\text{for } \frac{1}{\psi'} \prec x\right).$$

Thus, it follows from (2) that the first limit in (1) is 0 and from (3) that
$$\frac{\psi''(t)}{\{\psi'(t)\}^2} \sin \psi(t)$$
is continuous at $t=0$, its limit being 0. Therefore both the limits in (1) are existent and equal to 0. Therefore
$$\operatorname*{Lim}_{x=+0} \frac{F(x)}{x} = 0.$$

Similarly it can be proved that

$$\operatorname*{Lim}_{x=-0} \frac{F(x)}{x} = 0.$$

Therefore it is proved that $F'(0)$ exists and equals zero.

(*b*) Let $\psi(t) \prec \log \frac{1}{t^2}$.

Integrating by parts,

$$\int_0^x \cos \psi(t)dt = x \cos \psi(x) + \int_0^x t\psi'(t) \sin \psi(t)dt.$$

Now

$$\psi'(t) \prec \frac{1}{t}, \text{ i.e., } t\psi'(t) \prec 1.$$

Therefore $t\psi'(t) \,.\, \sin \psi(t)$ is continuous at $t=0$ and, consequently,

$$\int_0^x t\psi' \sin \psi dt$$

has a differential coefficient at $x=0$. Therefore, at $x=0$, $F(x)$ has no differential coefficient; for, $x \cos \psi(x)$ has no differential coefficient there.

(*c*) Let $\psi(t) \asymp \log \frac{1}{t^2}$.

If

$$\psi(t) = \alpha + \frac{1}{2} \log \frac{1}{t^2},$$

where α is a constant, it is easily seen that

$$F(x) = \frac{x}{\sqrt{2}} \cos\left(\psi(x) + \frac{\pi}{4}\right).$$

Therefore, whatever α may be, $F'(0)$ is non-existent. Generally, if

$$\psi(t) = \frac{1}{2}\left\{\sigma(t) + 1\right\} \log \frac{1}{t^2},$$

where $\sigma(t) \prec 1$, it can be proved that

$$F(x) = \frac{x}{\sqrt{2}} \cos\left(\psi + \frac{\pi}{4}\right)$$

and, consequently, $F'(0)$ is non-existent.

5. A still more general result * than the one given above is this:—

$$F(x) \equiv \int_0^x \chi(t) \cos \psi(t)dt$$

* For proof, see my paper in *Crelle's Journal*, Vol. 160.

has, for $x=0$, a differential coefficient or not, according as

$$\frac{\chi}{\psi'} \prec t,$$

or not;

χ and ψ being monotone.

6. What is of special importance in discussing the validity of various criteria for summability $(C\ 1)$, ordinary or strong, is the question, whether

$$F(x) \equiv \int_0^x |\chi(t) \cos \psi(t)|\, dt$$

has a zero differential coefficient for $x=0$. The simplest case is that of

$$F(x) \equiv \int_0^x \left| \cos \frac{1}{t} \right| dt$$

which was asserted by Fejér * in 1925 to have no differential coefficient for $x=0$ and which was proved by me in 1927 to have for $x=0$ the differential coefficient † $\frac{2}{\pi} \neq 0$. The proof is reproduced on the board ‡.

Generally, it can be proved § that for

$$F(x) \equiv \int_0^x |\chi(t) \cos \psi(t)|\, dt,$$

$$F'(0) \neq 0.$$

7. The problem of deciding whether $F'(0)$ exists in the case in which

$$F(x) \equiv \int_0^x \cos \psi(t) dt \text{ or } \int_0^x \chi(t) \cos \psi(t) dt$$

and $\psi(t)$ is *not* monotone, is a difficult one; certain particular cases have been studied by me. For example, || I have proved that

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* *l.c.*

† See my book, 'Six lectures on recent researches in the theory of Fourier series', 1928, pp. 64–67; or *Bulletin of the Calcutta Mathematical Society*, Vol. 19, pp. 1–12.

‡ See the appendix at the end.

§ *Bull. Calcutta Math. Soc., l.c.*

|| *Bull. Calcutta Math. Soc.*, Vol. 18.

$$F(x) = \int_0^x dt \,.\, \sin \cfrac{1}{\sin \cfrac{1}{\sin \ldots}}$$

$$\ldots \sin \frac{1}{t}$$

has a differential coefficient zero for $x=0$, there being a *finite* number of steps in the continued fraction, and that

$$F(x) \equiv \int_0^x dt \,.\, \sin^2 \log \sin^2 \log \sin^2 \log \ldots \sin^2 \log \frac{1}{t^2}$$

has no differential coefficient for $x=0$.

Summability Criteria.

8. Beginning with the criterion of Lebesgue for summability (C 1) for the Fourier series

$$\frac{1}{2} a_0 + \sum_{r=1}^{\infty} (a_r \cos rx + b_r \sin rx),$$

where

$$a_r = \frac{1}{\pi} \int_{-\pi}^{\pi} f(t) \cos rt \, dt, \; b_r = \frac{1}{\pi} \int_{-\pi}^{\pi} f(t) \sin rt \, dt,$$

the criterion for summability at $x=0$ may be given in the form

$$\Phi'(0) = 0,$$

where

$$\Phi(z) = \int_0^z \mid \phi(t) \mid dt,$$

$\phi(t)$ standing for

$$f(2t) + f(-2t) - 2S,$$

S being the limit to which the series is summable.

I need not explain how the above criterion is obtained. But I proceed to show that the scope of its validity is so narrow that it can be of no service in any case in which $f(x)$ has a discontinuity of the second kind like that in the case in which

$$f(t) = \cos \psi(t) \text{ or } \chi(t) \cos \psi(t)\,;$$

for, in these cases

$$\Phi'(0) \neq 0.$$

It has been, however, proved* by me that the series is summable (C 1) to zero even if $f(t)$ has one of the above forms in the neighbourhood of $t=0$, provided that

$$\frac{\chi}{\psi'} \precsim t \ \textit{and} \ \psi \succ \log \frac{1}{t^2}.$$

Note that when

$$\frac{\chi}{\psi'} \sim t \text{ and } \psi \succ \log \frac{1}{t^2},$$

there is summability (C 1) although

$$\int_0^x \chi(t) \cos \psi(t) dt$$

has *no* differential coefficient for $x=0$.

9. Taking the criteria for strong summability at x, we have first to consider the criterion of Carleman, viz.

$$\int_0^\delta | f(x+t)+f(x-t)-2S | \, dt=o(\delta), \quad .. \qquad .. \ (1)$$

$$\int_0^\delta \{ f(x+t)+f(x-t)-2S\}^2 dt=O(\delta) \quad .. \qquad .. \ (2)$$

As usual, taking for simplicity, $x=0$, we have for the case of

$$f(t)=\cos \frac{1}{t},$$

(1) becoming

$$\int_0^\delta \left| \cos \frac{1}{t} \right| dt=o(\delta),$$

which, as has been already proved, is not true.

So, Carleman's criterion does not prove efficient even in such a simple case in which we know that there is strong summability because of the criterion of Hardy and Littlewood holding true.

10. This last mentioned criterion is more general than Carleman's and is the following:—

If $p>1$ and

$$\int_0^t | \phi(u) |^p du=O(t), \quad .. \qquad .. \qquad .. \ (1)$$

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* See my book, pp. 69–72; or *Bull. Calcutta Math. Soc.*, Vol. 19, pp. 51–58.

$$\int_0^t \phi(u)du = o(t), \qquad \ldots \quad \ldots \quad \ldots \ (2)$$

where ϕ has the usual meaning, then

$$\sum_{m=0}^{n} | s_m - S |^q = o(n)$$

for every positive q and therefore for $q=1$.

It will be seen that for

$$f(t) = \chi(t) \cos \psi(t),$$

χ being unbounded, the first condition (1) cannot be satisfied.

Notwithstanding the fact that the criterion of Hardy and Littlewood is not satisfied in certain cases, there is strong summability (C 1).*

For example, it has been proved by me that if

$$f(t) = t^{-\frac{2}{3}} \cos \frac{1}{t},$$

there is strong summability, although the above-mentioned criterion is not satisfied.

11. Leaving summability (C 1), we note that in the case of summability (C 2), Lebesgue's criterion, viz.,

$$\operatorname*{Lim}_{z=0} \frac{1}{z} \int_0^z \{ f(x+2t) + f(x-2t) - 2S \} dt = 0$$

fails at $x=0$, when

$$\int_0^t dt\, f(t) = \chi(t) \cos \psi(t).\ t \text{ and } \frac{\chi}{\psi'} \prec t.$$

For example, if

$$f(t) = \frac{d}{dt} \left\{ t \left(\log \frac{1}{t^2} \right)^{\frac{1}{3}} \cos \left(\log \frac{1}{t^2} \right)^{\frac{2}{3}} \right\} \text{ for } t>0,$$

the series is summable (C 2) to 0 at $x=0$ although Lebesgue's criterion is not satisfied.†

Conclusion.

12. (a) My criticism of Lebesgue's criterion for summability (C 1) may be summed up as follows :—

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* See p. 102 of my book.

† See p. 78 of my book or *Bull. Calcutta Math. Soc.*, Vol. 19, pp. 25–28.

The various proofs* of the criterion start with the assumption that

$$\int_0^z |f(x+2t)+f(x-2t)-2S|\,dt$$

has a differential coefficient *equal* to 0 at $z=0$, and then deduce from the assumption that S is the limit to which the mean $S_n(x)$ must tend with n tending to infinity. As no proof considers explicitly the possibility of

$$f(x+2t)+f(x-2t)$$

having a discontinuity of the second kind, the assumption in reality amounts to the exclusion of the possibility of such a discontinuity. The proofs, thus, establish the validity of the criterion only for the case in which

$$f(x+2t)+f(x-2t)$$

has a limit when t tends to zero; and for this case, Fejér's original demonstration given in 1904 holds.

So far as Hardy and Littlewood are concerned, they did succeed in giving a criterion which covers the case in which $\phi(t)$ has a discontinuity of the second kind and is bounded, but not the case in which $\phi(t)$ is unbounded. Even this criterion admits of much generalization as proved by me.

(*b*) My criticism of the various criteria for strong summability (C 1) may be briefly stated as follows :—

Hardy and Littlewood did not detect the impossibility of the criterion of Carleman or that of Sutton being satisfied in any case in which $\phi(t)$ has a discontinuity of the second kind like that in the case in which

$$\phi(t)=\cos\psi(t) \text{ or } \chi(t)\cos\psi(t).$$

In fact, Hardy and Littlewood, approve of the aforesaid criteria. They say about their own criterion that it 'has more the air of finality' than the criteria of Carleman and Sutton. But, in reality, the problem of the strong summability (C 1) at a given point is of the same class as the problem of ordinary convergence or ordinary summability, and there is as little

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* See the proofs given by Lebesgue (*Math. Ann., Vol.* 61, 1905), Hobson and Schlesinger and Plessner. According to Hobson (p. 561 of Vol. 2 of his *Theory of Functions of a real variable*), 'a more general theorem than that of Fejér has been obtained by Lebesgue. He has in fact shown that the Cesáro sum converges to $f(x)$ at any point for which

$$\int_0^t |f(x+t)+f(x-t)-2f(x)|\,dt$$

has a differential coefficient equal to 0 at $t=0$.'

chance of a stage of finality having been reached in reference to any one of these problems as in reference to the other two. In fact, in 1927 I gave a case in which there is strong summability (C 1) although the criterion of Hardy and Littlewood is not satisfied.

For the case

$$\phi(t)=\chi(t)\cos\psi(t)$$

the various criteria are reproduced below for reference:

Prasad's criterion:—

$\psi \succ \log\frac{1}{t^2}$, $\frac{\chi}{\psi'} \prec t$ and further

$$\int_0^t \{\chi(u)\}^2 du \prec t^{1-\lambda} \text{ where } 1>\lambda>0.$$

Hardy and Littlewood's criterion:—

If $p>1$ and

$$\int_0^t |\phi(u)|^p du=O(t),$$

$$\int_0^t \phi(u)du=o(t),$$

then

$$\sum_0^n |s_m-s|^q=o(n) \text{ for every } q>0.$$

Sutton's criterion:—

If

$$\int_0^\delta |\phi(t)|^q dt=o(\delta),\ (0<q<1),$$

and

$$\int_0^\delta |\phi(t)|^p dt=O(\delta),\ (1<p<2)$$

then

$$\lim_{n=\infty}\frac{1}{n+1}\sum_{r=0}^n |s_r-f(0)|^{\frac{p}{p-1}}=0.$$

Carleman's criterion:—

If

$$\int_0^t \{\phi(u)\}^2 du=O(t),$$

and

$$\int_0^t |\phi(u)|\,du = o(t),$$

then

$$\sum_0^n |s_m - S|^q = o(n)$$

for all $q>0$.

APPENDIX.

*If $\Phi(z) \equiv \int_0^z \left|\cos\frac{1}{t}\right| dt$, then $\Phi'(0)=\frac{2}{\pi}$.

Proof:—

Consider

$$\Phi(z) \equiv \int_0^z \left|\cos\frac{1}{t}\right| dt;$$

and let

$$t_r \leqslant z < t_{r-1}, \qquad \ldots \qquad \ldots \qquad \ldots (1)$$

where

$$\frac{1}{t_r} = \left(r+\frac{1}{2}\right)\pi,$$

r being a positive integer.

Remembering that in the interval (t_r, z)

$$\left|\cos\frac{1}{t}\right| = (-1)^r \cos\frac{1}{t}$$

and, generally, in the interval (t_{r+m}, t_{r+m-1}),

$$\left|\cos\frac{1}{t}\right| = (-1)^{m+r}\cos\frac{1}{t},$$

we have

$$\int_0^z \left|\cos\frac{1}{t}\right| dt = \left\{ (-1)^r \int_{t_r}^z \cos\frac{1}{t}\,dt + \right.$$

$$\left. (-1)^{r+1}\int_{t_{r+1}}^{t_r} \cos\frac{1}{t}\,dt + (-1)^{r+2}\int_{t_{r+2}}^{t_{r+1}} \cos\frac{1}{t}\,dt + \ldots \text{to inf.} \right\}$$

$$= (-1)^r \left\{ \int_{t_r}^z \cos\frac{1}{t}\,dt - \int_{t_{r+1}}^{t_r} \cos\frac{1}{t}\,dt + \int_{t_{r+2}}^{t_{r+1}} \cos\frac{1}{t}\,dt - \ldots \right\}.$$

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* In his paper, Fejér says on the second page that for

$$f(x)=\cos\frac{1}{x}, \quad \operatorname*{Lim}_{h=+0} \frac{1}{2h}\int_{x-h}^{x+h} \left| f(t) - f \right| dt$$

does not exist when $x=0$, f standing for the sum $(C\ 1)$ of the Fourier series; this sum is known to be 0. Hence the mistake of Fejér.

Now

$$\frac{d}{dt}\left(t^2 \sin \frac{1}{t}\right) = 2t \sin \frac{1}{t} - \cos \frac{1}{t},$$

and, consequently,

$$\int \cos \frac{1}{t}\, dt = \int 2t \sin \frac{1}{t}\, dt - t^2 \sin \frac{1}{t}.$$

Therefore

$$\Phi(z) = (-1)^r \left[\left\{ \int_{t_r}^{z} 2t \sin \frac{1}{t}\, dt - \left(t^2 \sin \frac{1}{t}\right)_{t_r}^{z} \right\} \right.$$

$$- \left\{ \int_{t_{r+1}}^{t_r} 2t \sin \frac{1}{t}\, dt - \left(t^2 \sin \frac{1}{t}\right)_{t_{r+1}}^{t_r} \right\}$$

$$\left. + \left\{ \int_{t_{r+2}}^{t_{r+1}} 2t \sin \frac{1}{t}\, dt - \left(t^2 \sin \frac{1}{t}\right)_{t_{r+2}}^{t_{r+1}} \right\} - \ldots \text{to infinity} \right]. \quad (2)$$

Now, for

$$t = t_{r+m}, \quad (-1)^{r+m} . \sin \frac{1}{t} = 1.$$

Therefore the equation (2) becomes

$$\Phi(z) = \eta \int_0^z 2t \left| \sin \frac{1}{t} \right| dt - z^2 \eta_1 \left| \sin \frac{1}{z} \right|$$

$$+ 2 \left\{ t_r^2 + t_{r+1}^2 + \ldots \text{to infinity} \right\},$$

where η is numerically less than or equal to 1 and η_1 is ± 1. Now, obviously, the parts contributed to $\frac{\Phi(z)}{z}$ by the first two terms in the above expression each tend to zero with z. Therefore

$$\Phi'(0) = \operatorname*{Lim}_{z=0} \frac{2}{z} \left\{ t_r^2 + t_{r+1}^2 + \ldots\ldots \text{to infinity} \right\}.$$

But

$$t_r^2 + t_{r+1}^2 + \ldots\ldots = \frac{1}{\pi^2} \left\{ \frac{1}{(r+\frac{1}{2})^2} + \frac{1}{(r+\frac{3}{2})^2} + \ldots\ldots \right\}$$

$$= \frac{1}{\pi^2} \left\{ \frac{1}{r - \frac{1}{2} + k} \right\},$$

where $0 < k < 1$, because the sum of the series inside the crooked brackets is less than $\frac{1}{r-\frac{1}{2}}$ and greater than $\frac{1}{r+\frac{1}{2}}$.

Also, on account of (1),

$$\frac{1}{t_r} \geqslant \frac{1}{z} > \frac{1}{t_{r-1}},$$

i.e.,

$$\frac{1}{z} = (r - \tfrac{1}{2} + k_1)\pi, \text{ where } 0 < k_1 \leqslant 1.$$

Therefore

$$\Phi'(0) = \lim_{t=\infty} \frac{2}{\pi^2} \cdot \frac{(r - \frac{1}{2} + k_1)\pi}{(r - \frac{1}{2} + k)} = \frac{2}{\pi}.$$

Note.—The symbols $\succ$, $\prec$ and $\backsim$ are those used by Du Bois-Reymond in his Infinitary Calculus and have their usual meanings. Thus, if f_1 and f_2 are two monotone functions of x, f_1 is said to be $\succ$, $\prec$ or $\backsim$ f_2 according as $\lim_{x \to 0} \frac{f_1}{f_2} = \infty$, 0 or neither.

Section of Mathematics and Physics.

Abstracts.

1. On a New Photomagnetic Effect.

D. M. BOSE *and* P. K. RAHA, Calcutta.

In this paper an account is given of an experimental arrangement for detecting the change of susceptibility of paramagnetic solutions due to light absorption. It is found that solutions of $CrCl_3$, $FeCl_3$, $CoSO_4$, $NiCl_2$, $CuSO_4$ and a mixture of $Pr(NO_3)_3$ and $Nd(NO_3)_3$ show an increase of susceptibility under light absorption. Solutions of $TiCl_3$ and $CeCl_3$ under similar conditions do not exhibit any measurable change in susceptibility.

An attempt at a theoretical interpretation is made as follows. It has been shown by Van Vleck and Stoner that due to the presence of neighbouring ions and molecules, the coupling between the resultant spins and orbital moment l of the electrons present in the outer valency shell of a paramagnetic ion breaks down, and its magnetic moment is then represented by a formula given by Van Vleck $\mu = \sqrt{4s(s+1)+l(l+1)}$; instead by the usual Hund's formula. If further there is interpenetration of electron charges between the paramagnetic ion and the surrounding water dipole molecules, which gives rise to the associated complex of the type $[M_e nH_2O]^{++}$ etc., the orbital moment of the paramagnetic ion cannot orient itself freely in an external magnetic field, and therefore does not contribute its full quota to the magnetic moment of the ion. In the limiting case, the magnetic moment of the latter is represented by Bose's formula $\mu = \sqrt{4s(s+1)}$. On the assumption that the s in moment of the electrons alone contribute to the magnetic moment of the Cr^{+++} ion both in the initial $4F$ state and the metastable $2G$ resp. $2H$ state to which it is raised by light absorption, a diminution of moment is to be expected. Since on the contrary an increase is observed, this can be attributed to the breakdown of the l-coupling between the paramagnetic ion and the water dipoles surrounding it.

2. The Hyperfine-structure of Bismuth arc lines.

WALI MOHAMMAD *and* P. N. SHARMA, Lucknow.

The important lines of Bismuth arc in vacuum have been investigated between $\lambda\lambda$ 4722 and 2780, and their hyperfine-structure found by means of quartz Lummer plates and Hilger's 3-metre type quartz spectrograph. A specially constructed vacuum arc lamp as used in the previous investigations of the authors was employed. Two quartz Lummer plates were available and were used separately; the arc light was faint and so the crossed plates could not be used. The values found for the two plates agreed very well with one another as well as with those found by the previous investigators—Nagaoka and Goudsmidt and Back. Term-schemes of different lines have been worked out and the different term-separations calculated. The level p_4- has been found to be a doublet with a separation of 1·879 cm^{-1}, the p_2- level is four-fold with separations of ·163, ·209, ·262 cm^{-1} and the level p_3 is six-fold with separations of ·239, ·332, ·436, ·507, and ·557 cm^{-1}.

3. On an infinite system of Non-linear Integral Equations.

M. Raziuddin Siddiqi, Hyderabad, Deccan.

We consider an infinite system of non-linear integral equations whose coefficients satisfy certain conditions, and by taking successive approximations, we prove that one, and only one, solution of the system exists. In the case of two important examples, we show that the conditions of the problem are satisfied, and that the general theory is applicable in these cases. Finally we remark that the method is effective for higher equations of the type as well.

4. A new proof for the theorem of Hellinger and Toeplitz on bilinear forms in infinitely many variables.

A. Weil, Aligarh.

The theorem of Hellinger and Toeplitz is as follows:—

If a bilinear form $\sum_{i=1}^{\infty}\sum_{j=1}^{\infty} a_{ij}x_i y_j$ *in infinitely many variables is such that*

$$\sum_j \left(\sum_i a_{ij}x_i\right)y_j$$

converges whenever $\sum_i x_i^2$ *and* $\sum_j y_j^2$ *are both convergent, then the bilinear form is bounded.*

A new proof is given for this theorem. The proof is based on the following lemma, which is new and of some interest in functional calculus :

If a sequence of continuous linear functions in the Hilbertian space converges at every point, its limit is a continuous linear function ; and the sums of squares of the co-efficients in the functions of the sequence are uniformly bounded.

5. Note on a Mercury Radiation modified by transmission through Potassium Vapour.

Snehamoy Datta *and* B. K. Chakraverty, Calcutta.

On an examination of the spectrum of Mercury Vapour transmitted through potassium a *very faint* new radiation was observed at λ 3783. This new radiation may be explained as due to the modification of the energy quanta of radiation λ 2536 of Mercury by an amount equal to the inter-orbital transfer of the Potassium atom from the normal state to the next exited state.

It may thus be regarded as the optical counter part of the phenomena of part absorption observed by Dr. B. B. Ray in X-ray. It may also be explained as the modified Raman scattering corresponding to the aforesaid electric transition. No attempt has yet been made to study the effect in any direction other than the forward direction, hence it is not definitely known as to whether it is a case of part absorption or a modified Raman scattering involving electronic transition. But from the fact that the Raman lines corresponding to the vibrational transitions are absent under the condition of the experiment, it is more probable that the new radiation is due to a part absorption of the energy of the incident quantum.

6. New lines in the Absorption Spectra of the Alkalies.

Snehamoy Datta *and* B. K. Chakraverty, Calcutta.

As early as 1922, one of us in studying the absorption spectrum of Potassium Vapour (*Roy. Soc. Proc.* A—Vol. 101, p. 539) secured besides the

absorption of the lines of the principal series a number of new lines which made the appearance at comparatively higher pressure.

We have now been able to procure absorption of similar lines in the cases of Sodium and Rubidium, thus suggesting that this is a characteristic common to all the alkalies.

The divergences of these new lines in wave numbers from the nearest principal series line show a striking agreement with the wave numbers calculated from possible vibrational transition of the corresponding molecules and may be expressed by an equation

$$\nabla\nu=(w''n''-x''n''^2)-(w'n'-x'n'^2),$$

where w'', n'' etc. have their usual meaning.

A tentative explanation of the appearance of these lines as due to a triatomic molecular formation has been given.

7. Note on the observations of Eros made at the Nizamiah Observatory, Hyderabad, for the determination of Solar Parallax.

T. P. BHASKARA SHASTRI.

The recent opposition of the minor planet Eros afforded one of the most favourable opportunities for the determination of Solar Parallax. When nearest, the distance of the planet from the Earth was only about $\frac{1}{6}$ of an astronomical unit. More than 200 photographs of the asteroid were secured with the astrographic Equatorial of the Nizamiah Observatory. The telescope has a Cooke 8″ photovisual object glass (135″ F.L.) and is the same as that employed for the 'Cart du Ciel'. In order to secure the maximum parallactic effect, the plates were taken at as large hour angles (East and West) as possible. At opposition Eros was brighter than most of the Comparison stars and so, on some of the nights, a small filter was placed in front of the plate, absorbing part of the planets' light in order to make the image comparable with those of the stars. The guiding of the telescope was made only in R.A. allowing the planet to trail in declination. Each plate contains 8 to 20 images of the planet, the average exposure time being 2 minutes. A few plates have also been exposed on the meridian to be used as control on the Ephemeris.

The plates are being measured on one of the machines designed for the measurement of astrographic plates. It is fitted with an accurate scale in the eyepiece and the diaphragm containing the scale is moveable in x and y co-ordinates by micrometer screws; the scale readings can be made to ·0005 mm. Prof. Kopff has selected the comparison stars in the path of Eros and a definitive catalogue has been formed from the observations of these stars specially made with the meridian circle at a number of observatories. The reductions of the Hyderabad plates are in progress; and it is hoped that from the results obtained at the various observatories co-operating in this work, a more accurate value than that hitherto available, will be derived of this fundamental constant.

8. Finite Geometries.

A. A. KRISHNASWAMI AYYANGAR, Mysore.

Finite Geometries are a class of geometries in each of which there is a finite number of undefined elements called points falling into undefined sub-classes, viz., lines, planes and other derived spaces, which satisfy assumptions analogous to those obtaining in ordinary projective geometry.

The object of this paper is to discuss a new method of constructing a class of finite projective plane geometries and to study their properties. The method is based on finding modular sets of the type:—

$(X_1, X_2, \ldots\ldots X_N)$: Mod (N^2-N+1), where $X_r < X_r+1$

and the differences $X_r - X_s$ reduced with respect to mod (N^2-N+1) are all distinct. For example, the set (1, 2, 4, 9, 13, 19), mod 31, gives rise to a finite projective geometry of 31 points and 31 lines, there being 6 points on each line and 6 lines through each point.

Among the properties of a finite geometry built on a modular set, it is interesting to note that the group of points may be regarded as a simple plane (N^2-N+1)– point which is cyclically inscribed within itself in $(N^2-N)\ \phi\ (N^2-N+1)$ different ways, ϕ being the symbol of the totient-function.

Whether Desargues' and Pascal's theorems are true in *all* of these geometries is not yet fully investigated. In this connection, however, may be mentioned a new non-Desarguesian and non-Pascalian geometry of 91 points due to Veblen, Maclagan and Wedderburn. (*Vide* pp. 383, 384, *Transactions of the American Mathematical Society*, Vol. VIII, 1907.) The present author derives this geometry very simply from the number sets (1, 2, 4, 10), (2, 9), (4, 12), (3, 6, 7), and (8, 10), mod 13, and shows how the Pascalian Geometry of 13 points derived from (1, 2, 4, 10) is imbedded in a non-Pascalian one. Thus the new geometry contains a curious contradiction not perceived by the original discoverers.

9. The Diamagnetic Susceptibility of Binary Liquid Mixtures.

S. RAMACHANDRA RAO *and* G. SIVARAMAKRISHNAN, Annamalai Nagar.

We have determined the susceptibilities of mixtures of hexane and benzene, hexane and nitrobenzene, hexane and chlorobenzene, benzene and nitrobenzene, acetone and chloroform and benzene and carbon tetrachloride. The method used was by the Curie balance. In all these cases, straight line graphs were obtained between composition and susceptibility. There were no departures from the additive law. Experiments by the Quincke method by Ranganatham (*Nature*, 127, 975, 1931) and Hans Buchner (*Nature*, 128, 301, 1931) suggest small deviations (about two or three per cent.) for acetone and chloroform mixtures. The causes for this difference are briefly examined.

10. Influence of particle size on the Diamagnetism of Graphite and Bismuth.

S. RAMACHANDRA RAO, Annamalai Nagar.

The diamagnetic susceptibilities of colloidal particles of bismuth and graphite have been determined by the Curie method using a powerful electromagnet. In both cases it was found that a graph drawn between the inverse of the diameter and the mass susceptibility gave a straight line. This indicates that any increase in the surface area of a number of particles in a given mass of the substance by further sub-division, is accompanied by a proportionate decrease in the value of the diamagnetic susceptibility. This is what one should expect on the theory of Ehrenfest and Raman, namely that the high susceptibility values for graphite and bismuth are due to large electron orbits in the crystal lattice. Attention is drawn to the *rôle* of Richardson's structure electrons in magnetism.

11. The Influence of Temperature on the diamagnetic susceptibility of Acetic Acid.

S. RAMACHANDRA RAO *and* S. NARAYANASWAMI IYER, Annamalai Nagar.

Using a Quincke tube and heating the column of liquid between the pole pieces by an electric heater, the depression of the level was observed

by a sensitive microscope with an eye-piece scale. Experiments with acetic acid indicate that between 30 C and 100°C, there is no change in the value of the diamagnetic susceptibility. Light scattering experiments by one of us (*Ind. Jour. Phys.*, 3, 18, 1928) seem to suggest that there is a rapid decrease of molecular association in this range of temperature. It appears therefore that molecular association does not have any influence on diamagnetism, at any rate in the case of acetic acid

12. On certain infinite series of Legendre's functions with unrestricted degree and numerical argument.

N. G. Shabde.

Expansions of simple functions in infinite series of Legendre's Polynomials given by Bauer, Heine, Most, Hargreaves, Routh and others have been used by Forsyth, Hargreaves, Glaisher and Ramanujan to obtain numerical series for $\frac{1}{\pi}$ and $\frac{1}{\pi^2}$. The first successful attempt at the summation of infinite series of Legendre's functions, $P_n(\cosh\sigma)$ or $Q_n(\cosh\sigma)$, with non-integral n was only recently made by Ganesh Prasad and his work was continued by the present writer (*Bull. Cal. Math. Society*, Vol. XXIII, No. 3). These sums are functions of the complete elliptic integrals K, K', E, E' and $\Pi(n, k)$ and the moduli k and k'. In this paper an attempt is made by giving special values to the modulus k, to derive certain infinite series of Legendre's functions with numerical σ and n unrestricted having sums involving simple powers of π, for example

$$\frac{1}{\pi},\ \pi^{\frac{1}{2}},\ \pi^{-\frac{1}{2}},\ \frac{1}{\pi^{\frac{3}{2}}},\ \text{or}\ \frac{1}{\pi^2}.$$

Such values are given to k as will give for K, K', E, or E' expressions involving powers of π. These values of k are also used to find the numerical values of σ. Ten such series are obtained and further work is in progress.

13. On expansions of zero in series of associated Legendre's functions, $P_n^m(\mu)$.

N. G. Shabde.

Expansions of zero in infinite series of Bessel-functions have been given by Niels Nielsen and those in series of Lamé's functions have been given by F. Lindemann (*Mathematische Annalen*, volumes 52 and 19 respectively). Expansions of zero in series of Legendre's functions $P_n(\mu)$ are not possible with n integral, but may be possible with n not integral, as in the latter case the functions do not always form an orthogonal system. In this paper an attempt is made to expand zero in finite series of associated Legendre's functions, $P_n^m(\mu)$, $\mu=\cos\theta$. Two methods can be followed. One, analogous to that used by Lindemann for expansions in series of Lamé's functions, is to assume the required expansions in the form

$$\sum_{n=0}^{n}\sum_{m=0}^{m=n} A_n^m \cdot P_n^m(\mu),$$

to expand $P_n^m(\mu)$ in series of μ and to equate to zero the coefficients of different powers of μ. The coefficients A_n^m are determined from the resulting equations. Another method is to construct rational integral functions of $\cos\theta$, $\sin\theta\,.\cos\phi$, $\sin\theta\,.\sin\phi$, to expand these functions in series of $P_n^m(\cos\theta)$ and to put $\phi=0$ or $\frac{\pi}{2}$ in the end. The second method is well known and is indicated in several books on Spherical Harmonics. Lindemann's method is found more convenient when n is odd, the second

one, when n is even. Several expansions are possible even for a particular n. Some expansions for $n=2, 3, 4, 6, 8, 10$, and 16 are obtained, and further work is in progress.

14. On the expansion of $\theta_n(h)$ in the Lagrangian Remainder.

R. D. MISRA.

The problem of finding an expansion for $\theta(h)$ in powers of h assuming $f(x)$ to be unlimitedly differentiable and $f''(x)$ different from zero engaged the attention of Whitcom as early as 1880. Since then the problem has been attacked by well-known mathematicians, viz., R. Rothe and T. Hayashi, but Bhola Nath Pal was the first to go a step further than Whitcom by giving coefficients of h^5 and h^6.

The present paper is the outcome of my attempt to obtain the general term in the expansion of $\theta_n(h)$. I have not succeeded so far in my attempt, but I have obtained the coefficients of h^7 and h^8 in the expansion of $\theta(h)$.

It is to be noted that a general form for the coefficients can be given. It is

$$A_m=\Sigma K_m \phi_{a_1}{}^{\alpha_1} \cdot \phi_{a_2}{}^{\alpha_2} \phi_{a_3}{}^{\alpha_3} \ldots\ldots \phi_{a_\gamma}{}^{\alpha_\gamma}$$

a's and α's having all possible positive integral values subject to the condition, $a_1\alpha_1+a_2\alpha_2+a_3\alpha_3+ \ \ldots \ +a_\gamma\alpha_\gamma=m$. The problem to obtain the numerical factor K_m presents difficulties of the same order as in the case of finding numerical coefficients in the expansions of $\wp(z)$ or the Jacobian Elliptic functions $sn(z)$, $cn(z)$, $dn(z)$ in powers of z. Attempts of Hurwitz, and Herglotz made some years ago, and the recent paper read before the Toronto Congress, do not help much towards the solution of my difficulty.

15. A note on the Linear Difference Equation of the Third Order.

T. TOTADRI IYENGAR, Trichinopoly.

The linear difference equation has been studied by the method of determinants by several, notably by Sylvester, who seems to have been the first to note the connection between the continued fraction and the determinant. The present paper studies the third order equation from the point of view of the resulting continuant, without however using the method of determinants. The treatment follows closely that of Euler given in Chrystal's Algebra for the usual continuant. Properties are found similar to those in Chrystal's. One side of an identity of Sylvester's is re-obtained on combinatory lines. A like proof leads to a similar identity between a symmetric function of the roots of a special cubic and certain combinatory functions.

16. Probe electrode measurements in the Sodium Arc.

C. K. SUNDARACHAR, Bangalore.

The 'probe collector' method, the theory and use of which was developed by Langmuir and Mott-Smith (*Gen. Elec. Rev.*, 27, p. 449, 1924) has been utilised by several investigators to measure the mean electron energy, the space potential and the electron concentration in arc discharges. Measurements of this kind, so far, have been confined mainly to arcs in mercury vapour and in some of the rare gases. As pointed out by R. C. Mason (*Phy. Rev.*, Vol. 38, p. 440, Aug., 1931) a 'careful study of the cathode fall of arcs, with regard to the electron energies, may afford a better understanding of the phenomenon at the arc cathode'.

In the present paper is described the results of an investigation to measure these quantities in an arc through sodium vapour. In the type

of arc lamp devised and used in the experiment, the arc discharge could be passed, in the first instance, between a sodium pool as cathode and an iron rod as anode, the latter being cooled by a special arrangement, and in the second instance, between the same cathode and an ordinary type of tungsten anode, placed just below the iron electrode. A preliminary set of measurements indicate 6·2 volts, 0·9 volts, and $1 \cdot 5 \times 10^{14}$ electrons per c.c. for space potential, mean-electronic energy and concentration respectively, in a region close to the cathode, when the anode was cooled, the arc current density being 2 amps. cm^{-2}. The corresponding values when the tungsten anode was used in place of cooled iron anode were 7·5 volts, 1·3 volts, and 2×10^{16} electrons per c.c. for the same current density in the arc.

17. The Effect of X-rays on the Surface Tension of Soap Solution.

N. PARAMESWARAN *and* K. SESHADRI IYENGAR, Mysore.

In a recent paper published by Mr. Mahajan in the *Indian Journal of Physics*, Vol. VI, Part II some experiments are described which go to show that the Surface Tension of Boys' Soap Solution diminishes with the time of exposure to light. The authors of this paper have made certain interesting observations on the effect of X-rays on the same and experiments are in progress to confirm the results.

The Soap Solutions are, however, perfectly pure and prepared from extra-pure Oleic-acid, Ammonia, and Glycerine, as recommended by Lawrence in his book on the subject, page 26.

18. The Absolute of the In- and Ex-Circles. Part 2.

M. BHIMASENA RAO *and* M. VENKATARAMA IYER, Bangalore.

(Part 1 of this paper was read before the 7th Conference of the Indian Mathematical Society at Trivandrum.)

Taking the sides of a circular triangle *PQR* and its Hart's circle as circles of reference, the equation of the 'Absolute' is obtained, by the usual process, in the form

$$\operatorname{Cos}(S-2P)\sin^2\theta_1 + \ldots + \ldots + \cos S \,.\, \sin^2\theta_4 + 2\cos(S-P)\,[\cos\theta_2\cos\theta_3 + \cos\theta_1\cos\theta_4] + \ldots + \ldots = 0,$$

where P, Q, R are the angles of the Circular triangle and θ_1, θ_2, θ_3, θ_4 are the angles of intersection of any circle with the Circles of reference.

This expression is transformed into the Absolute of the Ex-circles and the in-circle of the circular triangle PQR, giving

$$Z_1{}^2\cot^2 r_1\left(\lambda_1{}^2 - \frac{\lambda_1\lambda_2\lambda_3\lambda_4}{\lambda_1 2}\right) + \ldots + \ldots + \ldots - 2(\lambda_2\lambda_3 - \lambda_1\lambda_4) \times (z_2 z_3 \cot r_2 \cot r_3 + z_1 z_4 \cot r_1 \cot r_4) - . - . = 0,$$

where Z_1, Z_2, Z_3, Z_4 are the powers of any point with respect to the Ex-Circles, r_1, r_2, r_3, r_4 their angular radii,

$$\lambda_1 = 4\sin\frac{E_1}{2}\cos\frac{E_2}{2}\cos\frac{E_3}{2}$$

with similar expressions for

$$\lambda_2,\ \lambda_3 \text{ and } \lambda_4 = 4\sin\frac{E_1}{2}\sin\frac{E_2}{2}\sin\frac{E_3}{2}$$

with $E_1 = P - E$, etc., and $2E = P + Q + R - \pi$.

The equation of the Hart's Circle is obtained in the form

$$\frac{z_1}{\lambda_1}\left[\frac{\lambda_1 + \lambda_4}{\lambda_2 - \lambda_3}\right] + \ldots + \ldots - \frac{z_4}{\lambda_4}\left[\frac{(\lambda_1 + \lambda_4)(\lambda_2 + \lambda_4)(\lambda_3 + \lambda_4)}{(\lambda_2 - \lambda_3)(\lambda_3 - \lambda_1)(\lambda_1 - \lambda_2)}\right] = 0,$$